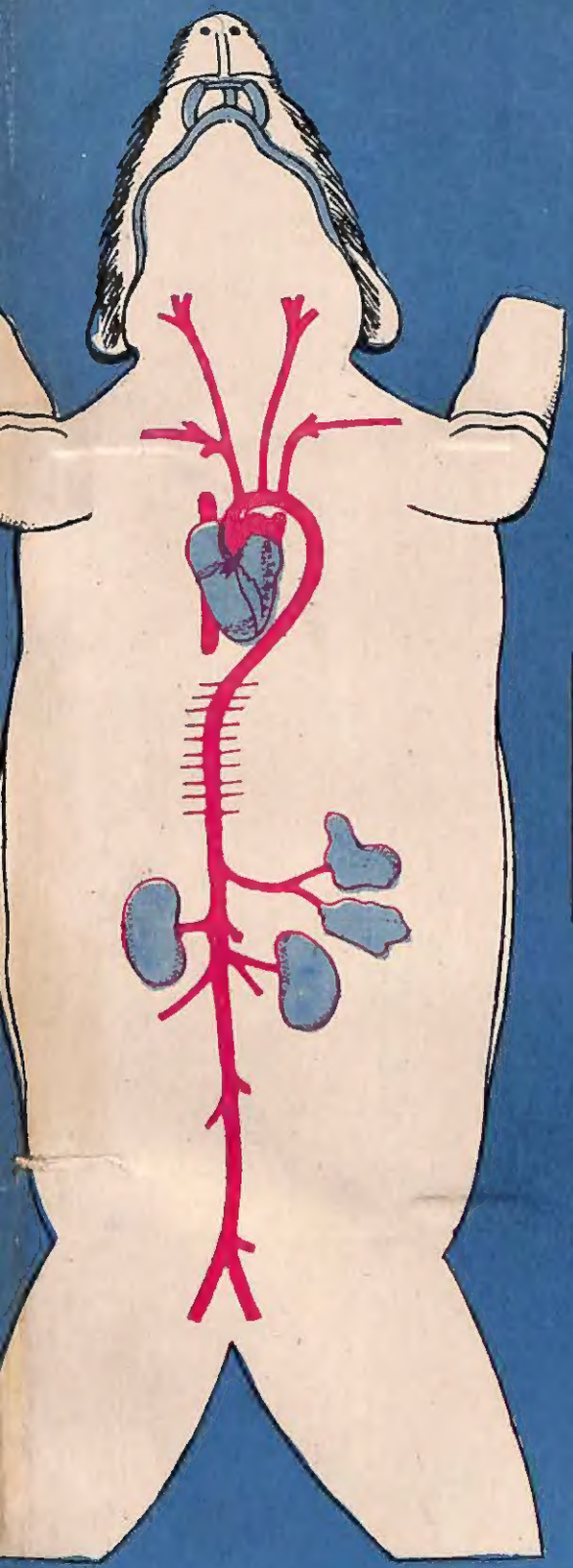

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PRACTICAL BIOLOGY

VOL. I

PITAMBAR PUBLISHING COMPANY

+ 2
PRACTICAL BIOLOGY

VOL. I FOR CLASS XI

[Strictly prepared in accordance with the latest syllabus in Biology Practicals prescribed for the All India & Delhi Senior School Certificate Examinations of the Central Board of Secondary Education, New Delhi]

By

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PREFACE

Under the New Education Policy, National Council of Educational Research and Training (NCERT) and Central Board of Secondary Education (CBSE) have prepared a new curriculum for secondary and senior secondary students. Basically, laboratory exercises help in including scientific aptitude, a keen observation, concise thinking, correct reasoning, proper interpretation and an analytical approach to the problem. The present syllabus lays more emphasis on the experimental approach. It makes students to carry out simple projects, which involves :

1. Selecting out a suitable problem for study,
2. Collecting all relevant study material associated with the problem selected,
3. Collecting required equipments, chemicals and other materials,
4. Conducting specific experiments and collecting datas,
5. Reaching some conclusion.

A biology student is, therefore, required to learn proper experimental techniques, correct usage of microscope, preparing reagents and stains, preparing temporary mounts, setting up simple experiments and carrying out field work.

The present practical book for Class XI of + 2 has been prepared strictly on the new syllabus prescribed by CBSE and NCERT. It includes both core experiments and investigatory projects as listed in the present curriculum.

Each experimental exercise is discussed under following heads — Aim, Material Required, Theory, Procedure, Observations, Interpretation, Discussion, Conclusion and Precautions. In the end of each exercise questions for viva voca are also given along with answers.

The book is essentially a laboratory manual. It is, therefore, written with a practical approach. It is profusely illustrated with simple, well labelled diagrams. The subject matter is discussed in point form to make it easily accessible. Observation tables are given at places required.

While peparing the book, author has consulted a number of Indian and foreign books and expresses her heart felt indebtedness to all of them.

Suggestions for the improvement of book are not only welcome but will be gratefully appreciated.

—V. B. RASTOGI

Syllabus in PRACTICAL BIOLOGY FOR CLASS XI prescribed by C.B.S.E. New Delhi.

One Practical Paper *3 hours* *30 Marks*

Students will be required to do 15 out of 23 Core Experiments and one out of 26 investigatory projects.

		Marks
(i)	Core Experiments	20
(ii)	Investigatory Projects	5
(iii)	Class Record & Viva	5

CORE EXPERIMENTS

1. An experiment to demonstrate the method of Science (Teacher may make use of any suitable experiment to cover the steps i.e., observation, definition of the problem, hypothesis, experimentation and conclusion).
2. Adaptibility of cockroaches to drastic environmental change.
3. Study of the parts of a compound microscope, proper use and maintenance.
4. Preparation of temporary stained slides of animal tissues (cheek squamous epithelial cells of man/ skin, squamous epithelial cells of frog) and plants (onions bulb peel/*Tradescantia* staminal hair/ algae) and highlighting similarities and diffferences in gross structures.
5. Tests for glucose, sucrose, starch, fat and protein and showing presence of these compounds in seeds (Peanuts/gram) and other tissues.
6. Staining and observing microscopically the cell wall components such as cellulose, lignin, suberin and mucilage.
7. Action of an inorganic catalyst (MnO_2) and enzyme (catalase) from potato/liver/plant tissues on hydrogen peroxide.
8. Factors affecting permeability of cell membrane in plants—Study of leaching of colour from beat root/plant tissues containing anthocyanin pigments due to heat, freezing and thawing, and chemicals (alcohol, formalin, benzene).
9. Effect of isotonic, hypertonic and hypotonic solutions on RBC and plant cells, haemolysis, crenation and plasmolysis.
10. Preparation of slides of frog buccal epithelium/gut ciliates of frog/paramoecium to study ciliary beat.
11. Collection, identification and preservation of plants and animals of the locality belonging to different groups and habitats.
12. Identification of *Amoeba, Paramoecium, Hydra,* liver fluke, *Ascaris,* leech, earthworm, prawn, crab, silkworm, honeybee, ants, spider, snail, bivalve slug, starfish, shark, rohu, *Anabas,* frog/toad, *Calotes* (lizard), sparrow/pigeon, guinea pig, rabbit.

13. Identification of Bacteria, *Oscillatoria, Spirogyra, Rhizopus,* Mushroom/bracket fungi, yeast, liverwort, moss, fern, Thuga (Biota), *Pinus,* One monocotyledon and one dicotyledon, lichens, root nodules of legume, *Cuscuta, Hydrilla/Elodea, Utricularia/Drosora, Cactus, Euphorbia.*
14. Determination of population density of plants by the quadrate method.
15. Study of a tree/bush or pond as an ecosystem.
16. To study the presence of pollutants in air and water-particularly SO_2, BOD, bioindicators.
17. Physical and chemical analysis of soil—pH.
18. (a) Study of the stomata through temporary slide preparation and effect of light, darkness, KCI and dehydration on the opening and closing of stomata. Measurement of stomatal aperture.
    (b) Study of the rate of transpiration through the upper and lower surface of leaf by cobalt chloride paper method in relation to stomatal count.
19. (a) Preparation of stained temporary slides of free hand, transvarse section of root and stem and macerated woody tissue.
    (b) Examination of a shoot and root meristem from a prepared slide.
20. Study effect of carbon dioxide and light intensity on the rate of photosynthesis.
21. Study of rate of aerobic respirations of flower buds/leaf tissue/germinating seeds.
22. Measurement of water potential of plant tissues (DPD).
23. Application of paper chromatography for the separation of plant pigments.

INVESTIGATORY PROJECTS

1. To study stained preparations of algae, fungi and musci.
2. (a) Preparation of a three-dimensional model of a plant or animal cell.
   (b) Preparation of a model of DNA.
   (c) Models of mitosis and meiosis.
3. Classification and general comments on 20 animals or plants found in the neighbourhood.
4. Determination of the essentiality of minerals for plant growth. Recording of deficiency symptoms.
5. Study of the breaking of dormancy of seeds by chemical and mechanical treatments.
6. Study of the effect of light and gravity on plant movements and the role played by them.
7. Study of pollen structure and calculation of pollen viability.
8. Comparative rate of pollen germination of various species.
9. Study of apical dominance in potato and *Coleus.*
10. Culture of soil micro-organisms.
11. Study of soil litter fauna.
12. Effect of light on sporulation in fungi.

13. Study of *Cuscuta* and its adaptation for a parasitic mode of life.
14. Study of the effects of 2 - 4-D on translocation process.
15. Study of effect of gibberellin on germination and Shoot elongation.
16. Effect of a herbicide on a lawn with weeds (to compare the effects on monocotyledons and dicotylendons).
17. Dispersal of seeds by various agencies.
18. Study of canopy architecture of trees.
19. Effect of avenue trees on temperature.
20. Study of particulate matter collected by the foliage of road-side trees.
21. Pollination in sunflower or Legume etc.
22. Study of flower colours in the garden.
23. Estimation of productivity capacity in five plants grown under different conditions.
24. To study the chlorophyll content in five different species of plants.
25. To study opening and closing of stomata.
26. To study osmosis and plasmolysis in plants.

CONTENTS

INTRODUCTION

General Instructions—Practical Record—Study of Museum Specimens—Study of Slides—Spotting —Drawings—Solutions and Stains.

LABORATORY TECHNIQUES

Smar method—Section cutting—Maceration—Staining

CORE EXPERIMENTS

INVESTIGATORY PROJECTS

INTRODUCTION

1. EQUIPMENTS

For practical work in the laboratory, a biology student is supposed to have following things :

- ... Laboratory note book.
- ... Guide book for practical.
- ... Pencils, preferably H and HB.
- ... Pencil sharpener.
- ... Eraser.
- ... Dissection box containing :
  - ... Two pairs of scissors, one fine tipped, smaller one for fine dissections and other larger one for general work.
  - ... Two fine forceps, in exceptionally good condition and with very fine tips.
  - ... One big forceps with blunt ends for rough work.
  - ... Two scalpels.
  - ... Two dissecting needles.
  - ... A blow pipe.
  - ... An arrow head.
- ... Safety razor or blade.
- ... A piece of clean absorbent cloth.
- ... Magnifying glass.

Do not mind bringing all these things on every turn. You do not know when you may need them.

GENERAL INSTRUCTIONS

1. While coming to the practical class, check that you have **complete set of dissecting instruments, practical note book, pencil, eraser, sharpener, scale and brush.**

2. Instruments should be sharp and in working order.

3. **Come well prepared with the work you are supposed to do in the practical class.**

4. Do not forget to enquire about the work to be done in the next class.

5. Keep your seat, instruments and practical record well arranged and tidy.

6. **Never encourage lending** either to or from your classmates.

7. Never rub pencil on the floor or on table to sharpen it, use sharpener or blade.

8. Before starting the work listen the instructions carefully.

9. **Do not consult your classmates** for any help. Get your difficulties solved from teacher only.

10. Maintain complete silence in the **laboratory.**

11. Clean and arrange your seat **before** you leave.

PRACTICAL RECORD

1. Practical record should be neat and clean and up-to-date.

2. Diagrams should be well labelled and correctly drawn.

3. Do not forget to write down the date on every page.

4. Never postpone today's work for tomorrow.

5. Draw diagrams of all the specimens, slides, dissections and mounting etc., and also write their comments.

STUDY OF MUSEUM SPECIMENS

1. First study the characteristics of the specimen to be drawn.

2. Try to find out those characteristics in the specimen.

3. Draw only that view (dorsal, ventral or lateral) of the specimen which presents maximum details.

4. **Diagram should be drawn from the actual specimen.** Take help of the book for comparing and labelling the various parts.

5. While drawing maintain the proportion of length and width of the animal body in your drawing.

6. Sketch line diagrams ; **shading should be avoided.**

7. Always write down the classification of entire specimen.

STUDY OF SLIDES

1. While studying slides under microscope, **do not disturb the slides focussed by the teacher.** If you are not able to follow, seek the help of your teacher.

2. Draw from the slide and not from the book.

SPOTTING

During examination remember the following points :

1. **Always write spot number.**

2. Draw a rough but correct and well labelled diagram of the spot.

3. Give classification of the entire specimen, but no classification is required for sections and larval forms.

4. Give at least one distinguishing feature of phylum, subphylum, class, subclass, order and sub-order to justify the systematic position of the specimens.

5. Only important and interesting features should be given at the time of spotting.

DRAWINGS

1. Observe and study the specimen or slide well before drawing it in the record book.

2. **Draw directly from the specimen or slide.** Drawing from the book are readily recognised by the examiner and teacher and are not appreciated.

3. Drawings are graded on correctness, completeness and neatness and not on the artistic merit. Therefore, these should be simple and clear and only in the form of outlines.

4. Mark each figure large enough to show all the details clearly.

5. Use a sharp hard pencil.

6. First make the outline of the specimen lightly. If the specimen is bilaterally symmetrical, first draw the median longitudinal line as a temporary guide, draw the details on one side first and then repeat them on the other side at the same level. Finally erase the unnecessary marks.

7. Draw the diagrams in the middle of the page so that you get plenty of space for labelling its different parts.

8. Label every part in each figure. All the labels should be parallel. Draw a fine line from each part of the figure upto the label.

9. These lines should not cross.

10. Under the sketches of slides do not forget to mention the low magnification or high magnification.

2. SOLUTIONS

Solutions are homogeneous mixtures of two or more substances in relative quantities up to the limit of solubility. Solution of common salt in water and water and sugar or water and alcohol are the common examples. Liquid is usually called *solvent* and the substance dissolved *solute*.

The concentration of any component in a solution may be expressed in

(*a*) Percentage by weight.

(*b*) Molar solution.

(*c*) Normal solution.

(*d*) Percentage by volume.

A. Percentage by Weight

(1) *1% NaCl Solution :* 1 g NaCl dissolved in 100 ml of water, or 1000 mg NaCl dissolved in 100 ml of water.

(2) *0.9% NaCl Solution :* 9 g NaCl dissolved in 1000 ml of water. (*Mammalian Saline*)

(3) *0.64% NaCl Solution :* 640 mg. of NaCl dissolved in 1000 ml of water. (*Amphibian Saline*)

B. Molar Solution

Molar solution contains 1 g mol. wt. of substance dissolved in 1 litre of solution. For example : (1) 1 M HCl solution contains 36.5 g of HCl dissolved in 1 litre of solution. (Mol. wt. of HCl = 1 + 35.5 = 36.5). (2) 0.2 M NaCl Solution : Mol. wt. of NaCl = 58.5. To get 1 M NaCl, dissolve 58.5 g NaCl in 1000 ml of water. To get 0.2 M NaCl, dissolve $\frac{58.5 \times 2}{10}$ = 11.7 g of it in 1000 ml of water.

To get M/15 solution, divide the molecular weight by 15 and then dissolve the weight in grams in 1000 ml of water.

C. Normal Solution

A *normal solution* contains 1 gram equivalent weight of a compound in a litre of solution. A gram equivalent weight is equal to gram molecular weight divided by the total valency of its positive or negative ions. Thus, 1 N solution of HCl 1 gram molecular weight of HCl = 36.5.

Total valence of positive ions = 1

Therefore, 36.5 g of HCl in 1 litre of water will give 1 N HCl solution. Here, 1 M HCl = 1 N HCl solution.

1 N H_2SO_4 solution = Gram equivalent weight

$$= \frac{\text{Molecular weight}}{\text{Valency}} = \frac{98}{2} = 49$$

Never weigh acids as grams on balance but divide equivalent weight by specific gravity and then proceed.

Therefore, Gram equivalent weight

$$= \frac{\text{Equivalent weight}}{\text{Specific gravity}} = x$$

Measure x-ml of acid and dissolve in 1000 ml of water to get 1 N H_2SO_4 solution.

1. Preparation of other Stock and Culture Solutions

1. *Benedict's Reagent (for Reducing Sugar) :* Dissolve 173 gms of crystalline *sodium citrate* and 100 g of anhydrous *sodium carbonate* (Na_2CO_3) in about 800 ml of water. Stir thoroughly and filter. To the filtered solution add 17.3 gms of copper sulphate dissolved in 100 ml of water. Make up to one litre with distilled water.

2. *Burette Reagent (for protein test) :* (*a*) 0.01 M copper sulphate ($CuSO_4$) : Dissolve 2.5 g of $CuSO_4$ in a litre of water, (*b*) 10 M Sodium hydroxide (NaOH): Dissolve 440 g of sodium hydroxide in sufficient amount of water make up to 1 litre volume. Mix the above two and store.

3. *Knop's Solution :* Divide a litre of distilled water into four parts of 250 ml each. Dissolve the following salts in each of the 250 ml parts, taking one salt for each part :

(*a*) $MgSO_4.7H_2O$ (10 g),

(*b*) K_2HPO_4 (20 gms),

(*c*) KNO_3 (1.00 g), (*d*) $Ca(NO_3)_2.4H_2O$ (10 g).

Combine the four solutions, adding $Ca(NO_3)_2$ solution last. Add 1 drop of 4% $FeCl_3$ solution (freshly made) to this solution. For use, dilute it with same volume of distilled water. This has a pH of about 7.6.

There have been many modifications of the original Knop's solution formula for the cultivation of algae and other plants.

4. *Modified Knop's Solution (after boiled, for cultivation for algae)*

(*a*) $Ca(NO_3)_2$ (4.0 g)

(*b*) Monobasic potassium phosphate (K_2HPO_4) (1.0 g)

(*c*) Potassium nitrate (KNO_3) (1.0 g)

(*d*) Ferric chloride ($FeCl_3$) 1% Soln (2 drops).

(*e*) Distilled water 700 ml.

Dissolve all of them in 2000 ml of water. This yields a 0.6% stock solution. Use measured small quantities, 1 drop, 10 drops, 20 drops, per litre in making up the various culture solution for algae.

5. *Nutrient Agar*

(*a*) Peptone (5.0 g)

(*b*) Beef extract (3.0 g)

(*c*) Agar (15.0 g)

(*d*) Distilled water (1000 ml).

Heat water (below boiling) and dissolve agar first, then add peptone and beef extract. Sterilize in an autoclave (pressure cooker) for 15 minutes at 15 Ib pressure (121°C). While it is still hot, pour it into sterile petri-dishes.

6. *Starch Solution* : To get 100 ml of starch solution, take 1 gm of soluble starch and dissolve it in 10 ml of distilled water. Heat the rest 90 ml of water in beaker at 90°C till bubbles appear. Remove this from the burner and add 10 ml of starch solution. Slowly stir the mixture in the flask and then leave this solution overnight. Reject the sediment and transfer the supernatent to a beaker for use.

7. *Iodine Solution* : Prepare stock solution of 1% iodine (Lugol's I_2 Soln) by taking 1 gm of iodine and 2 gms of potassium iodide. Dissolve in 100 ml of distilled water. Dissolved the KI in water first, then dissolve the iodine crystals. Dilute this 1% stock solution of iodine for further use.

8. *Ringers Solution (Isotonic Salt Solution)*

(*a*) Potassium chloride (KCl) (0.42 g)

(*b*) Calcium chloride ($CaCl_2$) (0.24 g)

(*c*) Sodium bicarbonate ($NaHCO_3$) (0.20 g)

(*d*) Distilled water (1000 ml).

9. *Mammalian Saline (0.9% NaCl) :*

Sodium chloride (NaCl) : 9.0 g of NaCl in 1000 ml. water

10. *Amphibian Saline : (.75% NaCl)*

Sodium chloride 7.5 g dissolved in 1000 ml water.

11. *For Invertebrate tissue prepare 0.6 % NaCl by dissolving 6 gm NaCl in 1000 ml water.*

12. *Buffer Solution (from pH 5.3 to 8)* : Prepare the following stock solutions to produce buffer solutions in the range indicated.

(*a*) Disodium Hydrogen Phosphate– $Na_2HPO\ 12H_2O$. To produce M/15 solution, dissolve 23.88g of $Na_2HPO_4 . 12H_2O$ in distilled water to make 1 litre of the solution.

(*b*) Potassium Dihydrogen Phosphate (KH_2PO_4): To prepare M/15 solution, dissolve 9.08 g of KH_2PO_4 in distilled water to make 1 litre of solution.

Mix the two stock solutions in the amounts indicated in the following table or (in the multiples of these quantities) to produce the required amount of buffer solution of the specified pH.

TABLE 1-1 : Buffer Solution

pH	M/15 Na_2HPO_4 (ml)	M/15KH_2PO_4 (ml)
5.4	3.00	97.0
5.6	5.00	95.0
5.8	7.8	92.2
6.0	12.0	88.0
6.2	18.5	81.5
6.4	26.5	73.5
6.6	37.5	62.5
6.8	50.0	50.0
7.0	61.1	38.9
7.2	71.5	28.5
7.4	80.4	19.6
7.6	86.8	13.2
7.8	91.4	8.6
8.0	94.5	5.5

3. STAINS

Stains are dyes or the colouring materials for various plant and animal tissues for microscopic study. These dyes give specific colour to the tissue. Different stains are used for different organelles. A few stains used in the class are given below :

1. Safranine

It is perhaps the most important stain. It stains lignified, cutinized, and suberized structures as well as chromosomes, nucleoli and centrosomes. Safranine ordinarily dissolves better in concentrated alcohol than in water.

Preparation of Stock Solution : By dissolving 2.25 g of certified sample of safranine in 225 ml of 95% ethyl alcohol and a part of this stock solution diluted with an equal volume of distilled water when needed for use. If this solution proves to be too strong, it may be further diluted with 50% alcohol.

2. Acetocarmine

It is used for chromosome studies. It is prepared by taking (*a*) glacial acetic acid (45 ml) and (*b*) distilled water (55 ml) and carmine powder.

Boil this 45% acetic acid in a beaker over a water bath, because acetic acid is inflammable. Slowly add 2 g of carmine powder to the boiling acetic acid and go on stirring. Then filter and store in bottle.

Add a few drops of freshly prepared ferric chloride solution before use.

3. Fast Green

(*a*) Fast green (1.00 g)

(*b*) 90% alcohol (100 ml).

It is a good stain for thin-walled cells.

4. Eosin

It is red coloured cytoplasmic stain for animal tissues.

Aqueous Solution : This contains : (*a*) Eosin (1.00 g) and (*b*) water (100 ml).

Alcoholic Solution : This contains : (*a*) Eosin (1.00 g) and (*b*) 70% Alcohol (100 ml).

5. Methylene Blue

It is a nuclear stain. It is used to stain pollen grains, bacteria, yeast, nerve cells and epithelial cells. Its constituents are (*a*) Methylene blue stain (0.3 g), (*b*) 95% ethyl alcohol (30 ml) and (*c*) Distilled water (100 ml).

6. Janus Green B Stain

It is vital stain for mitochondrion. To get 0.1% of stain, (*a*) weigh 100 mg of stain, (*b*) weigh 640 mg of NaCl and put it in 100 ml of distilled water to get .64% NaCl solution, (*c*) take .64% soln of NaCl and add 100 mg of stain.

7. Iodine :

Preparation has been given. The colour reactions of iodine on sections are as follows :

Blue	*Brown*	*Yellow*
Starch	Cellulose	Cutin
	Proteins	Callose
		Cork

8. Phloroglycinol

For testing presence of lignin, take (*a*) Phloroglycinol (2 g) and (*b*) distilled water 98 ml. Treat the section of the plant material with a drop of dil. HCl, after staining.

9. Sudan III

Sudan III is replaced by Sudan IV. It is specific for fats, its solubility in water is nil. So prepare a saturated solution of Sudan IV stain in 95% ethyl alcohol. Filter the supernatent and store for further use.

Table of Stains for Specific Structures

1. *Cellulose Cell Walls*

   (*a*) Iodine solution : cellulose walls become blue black or dark brown.

   (*b*) Congo-red : cellulose walls become red.

2. *Cutinized Cell Walls*

   (*a*) Methylene blue

   (*b*) Safranine

3. *Cytoplasm*

(*a*) Fast green

(*b*) Eosin

4. *Dividing chromosomes*

(*a*) Aceto-carmine

5. *Fats*

(*a*) Sudan III or IV

6. *Lignified Cell Walls*

(*a*) Safranine

(*b*) Phloroglycinol—Red or Pink colour of lignified cell wall.

7. *Mitochondrion*

(*a*) Janus green B

8. *Nuclear (General) Material Contents*

(*a*) Acetocarmine

(*b*) Safranine

(*c*) Methylene blue

9. *Proteins*

(*a*) Safranine

10. *Suberized Cell Walls*

(*a*) Safranine

(*b*) Sudan III or IV

C. Gram's Staining Technique for Bacteria
Ammonium oxalate-crystal violet stain

Solution A

2 g crystal violet (Gentian violet) dissolved in 20 ml ethyl alcohol (95%).

Solution B

1.0 g ammonium oxalate $(NH_4)_2C_2O_4 . H_2O$) dissolved in 100 ml of distilled water.

Mix solution A and B.

Make a bacterial smear on a clean slide and show the flame to the slide and take it up for fixing.

Stain the bacterial smear in this mixture for one minute. Wash in water. Immerse in Lugol's iodine solution (1 gm iodine, 2 gm potassium iodide and 300 ml distilled water) for 30 seconds, wash in water.

Decolorize in 95% alcohol for 30 seconds with gentle rotation of the slide. Cover with safranine counter stain (10 ml of a 2.5% solution of safranine in 95% alcohol) for 3 minutes. Wash in water and let it dry. Put a drop of glycerine and cover with the coverslip.

N.B. Bacterial smear can be prepared from dirty water, root nodules of leguminos plants or supernatent from curd.

The bacteria which retain the stain are called gram positive bacteria but others which lose the stain are called gram negative bacteria.

Gram +ve bacteria : will retain crystal violet stain and appear blue (violet).

Gram –ve bacteria : will retain safranine and will appear pink.

ORAL QUESTIONS

Q. 1. *What is a solution ?*

Ans. Solution is a homogeneous mixture of two or more substances.

Q. 2. *What is the difference between a true solution and a colloidal solution ?*

Ans. Differences between true solutions and colloidal solutions

	Property	True Solutions	Colloidal Solutions
1.	Size of Particles	Solute particles have diameters between .1nm to 1nm	The diameter of colloidal particles ranges from 1nm to 100nm

2.	Nature of solute	Solute is in molecular or ionic form.	Dispersed phase is multi-molicular, macromolecular or associated colloid.
3.	Homogeneity/ Heterogeneity	Homogeneous mixture of a solute and a solvent	Heterogeneous system.
4.	Settling nature	Do not settle	Settle in a centrifuge
5.	Diffusibility	Diffuse readily	Diffuse slowly
6.	Tyndal effect	Do not show.	Show tyndal effect.
7.	Brownian movement	Do not show.	Show Brownian movement.
8.	Visibility	The particles of a solute are invisible even under micro-scope.	The colloidal particles cannot be seen by naked eye but can be seen under ultra-microscope.

Q. 3. *What is molar solution ?*

Ans. A molar solution is 1 g mol. weight of a substance dissolved in a litre of water.

Q. 4. *What is a normal solution ?*

Ans. A normal solution contains 1 gram equivalent weight of a substance in one litre of water.

Q. 5. *What is amphibian saline ?*

Ans. ·64% NaCl solution.

Q. 6. *How will you prepare mammalian saline ?*

Ans. Mammalian saline is .9% NaCl dissolve 9 g NaCl in one litre water.

Q. 7. *What is a buffer ?*

Ans. It is a solution of amphoteric ions or a salt which resists changes in pH of the solution or medium providing either anions or cations as needed.

Q. 8. *Name two nuclear stains :*

Ans. Haematoxylin, Acetocarmine.

Q. 9. *What is a stain ?*

Ans. A colouring agent used to colour plant or animal body or its cells.

Q. 10. *Which stain is used to study nuclear division ?*

Ans. Acetocarmine (Nuclear stain).

Q. 11. *What solutions are used for staining gram positive bacteria ?*

Ans. (*i*) Gram's stain (a mixture of Gentian violet and ammonium oxalate). (*ii*) These are then differentiated by Lugol's iodine solution.

□□

LABORATORY TECHNIQUES

To test and confirm experimentally the various concepts learnt in the classrooms, the student does practical work in the laboratory. This involves the learning of various techniques like those of a maceration, staining, mounting, section-cutting dissections etc. Some of these techniques have been discussed here.

I. SMEAR METHOD

Smear methods are useful for cytological studies *i.e.*, structure of cell and counting and studying of chromosomes. This method is applicable to cells which are not firmly united to one another by middle lamellae *e.g.*, Microsporocytes, cells of testis, etc. In this technique the cells are spread out into a single layer and cells get adhered to the slide.

Technique

(1) Clean the glass slide and cover slip.

(2) Place a few small young anthers, in a drop of aceto-carmine on the slide.

(3) After a few minutes, withdraw the fluid with blotting paper and replace with a fresh drop of stain.

(4) Warm the slide, so that the cell get properly stained, then cool it by touching the back of your palm.

(5) Replace the previous stain by a fresh drop of stain.

(6) Put the coverslip over the material avoiding tapping of air bubbles.

(7) Make the smear of another stain in two ways : Either :

(*a*) Tap gently with back of the needle on the cover slip over the material, or

(*b*) Put the glass slide in the fold of blotting paper. Press gently over the paper on cover slip by thumb. This results in the uniform spreading of the material.

(8) Observe the slide under low and then under high power of microscope.

II. SECTION CUTTING

"Free hand sections" are those sections which are cut by means of a razor from material held in hands or placed in pith. Transverse, radial, or longitudinal section of the material reveals anatomical details of the material, like place and shape of various tissues.

Technique

(1) Make 2-3 cm long pieces of the material to be sectioned, *e.g.*, stem, root or leaf.

(2) Cut long cylinders of some soft material like potato, carrot etc., with the help of cork borer. This is used as a pith—a supporting material for section cutting.

(3) If leaf is to be sectioned or the material to be sectioned is thin and narrow then make an incision on pith with blade and insert the piece of material in it, gently.

(4) If material is thick and cylindrical like stem or root, then make a narrow hole in the pith cylinder by digging with help of a needle. Now insert gently the material in this hole. This hole should not be very narrow or broad.

(5) Material should get properly fixed in the pith.

(6) Hold the pith material between thumb and first finger of your left hand (see Fig. 3.1).

(7) The pith must be in a horizontal plane.

(8) Hold the razor in the right-hand, with edge of blade facing you and handle at right angles to it (see Fig. 3.1).

(9) Dip the blade or razor in water. Dip the top of pith material in water.

(10) Start cutting transverse sections of the pith material quickly (see Fig. 3.1).

(11) You get sections of pith and material contained in water.

(12) Select the thinnest section of the material with the help of a delicate brush, and place it in a drop of water on a glass slide.

(13) Observe it under a compound microscope after staining and mounting.

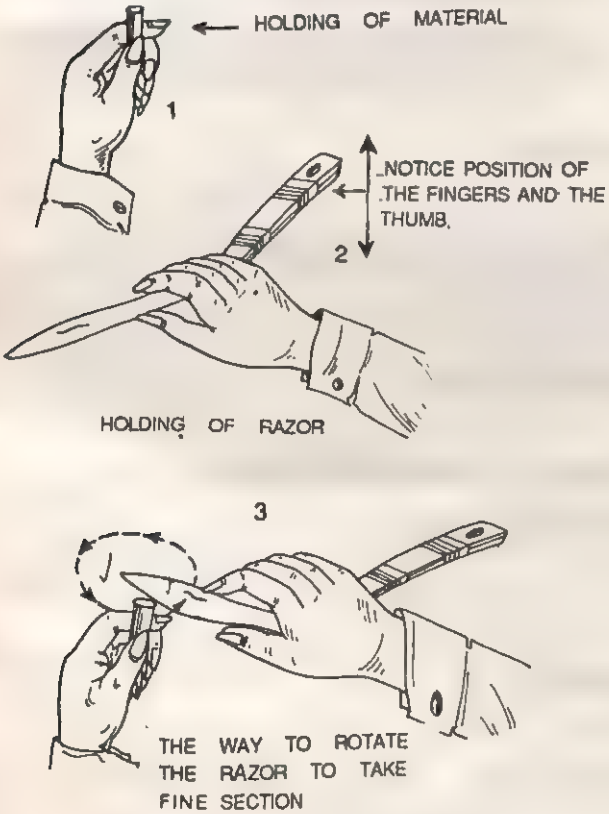


Fig. 3.1 : Technique of section cutting.

III. MACERATION OF TISSUES

The sections of stem or root reveal the anatomical details but do not really convey the clear conception of real nature of the cells of which they are composed of. This is only possible if these cells are separated from each other. For this a plant organ is treated with chemicals to dissolve middle lamellae and then the cells get dissociated. This technique of dissociation of cells by the use of chemicals is known as *maceration*.

Technique :

(1) Take small pieces of the material in a test-tube.

(2) Pour enough concentrated HNO_3 to cover the material and a few crystals of potassium chlorate.

(3) Heat the tube, preferably in a water bath until the material gets bleached.

(4) Take a small sample from the test-tube. Wash it with water. Make a mount and see if the cells have got separated or not. If so, stop heating further otherwise continue heating till the entire cells can be isolated.

(5) Wash thoroughly in water and centrifuge.

(6) Stain the macerated tissue in safranine and then observe under a compound microscope.

STAINING

Staining is one of the essential steps in biological studies. The cells, tissues, organs or small animals are stained with specific dye (stain) so as to differentiate its various parts under the microscope. The various stains used in the class have already been discussed.

Procedure of Staining :

(1) Take a clean slide.

(2) Put a drop of culture containing animal to be studied or put a section or part to be stained.

(3) Put a few drops of stain recommended on the tissue. Cover it with stain properly.

(4) Leave the slide for 3-5 minutes.

(5) Drain of stain and wash with water if necessary.

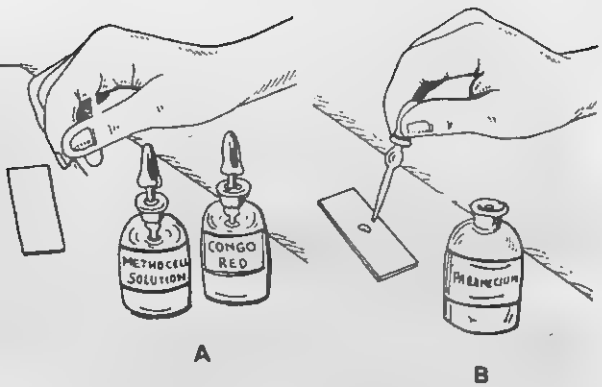


Fig. 3.2 : Diagram showing procedure of staining of paramecia.

Mounting :

To avoid drying of the material while studying, the material is mounted in glycerine and covered with coverslip. Procedure is as follows :

1. Put the material in the centre of the slide.

2. Put a drop of glycerine over the material.

3. Cover it with a coverslip with the help of a needle as shown in the Fig. 3.3.

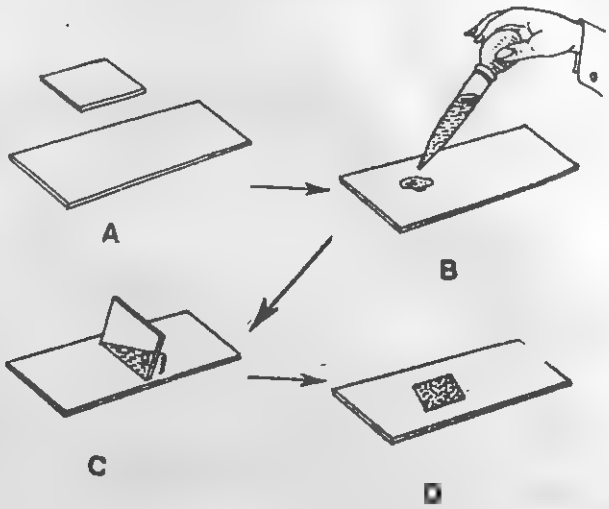


Fig. 3.3 : Procedure of mountaing

Study under the Microscope :

Focus the slide under low power of microscope and then change to high power if needed.

ORAL QUESTIONS

Q. 1. *In what cases smear preparation is useful ?*

Ans. Smear preparation is useful for cytological studies especially for the study of structure and number of chromosomes.

Q. 2. *What is smear preparation ?*

Ans. It is spreading of cells on the slide into a single layer by pressing.

Q. 3. *What is the use of pith in section cutting ?*

Ans. *Pith* is a supporting material used while cutting sections of some thin and soft material like leaf.

Q. 4. *What precautions will you take while preparing hand-cut sections ?*

Ans. 1. Razor or blade must be sharp.

2. Material shall be handled straight.

3. Razor shall be kept horizontal while cutting sections.

4. Cut thin sections.

5. Put some water on razor or blade while cutting sections.

Q. 5. *What is maceration ?*

Ans. The technique of dissociation of cells by the use of chemicals is known as maceration.

Q. 6. *What chemicals are used for maceration ?*

Ans. For maceration of plant tissue conc. HNO_3 and crystals of potassium chlorate are used.

Q. 7. *What is the use of maceration technique ?*

Ans. Maceration helps in three-dimensional study of cells composing a particular tissue.

□□

CORE EXPERIMENT 1
SCIENTIFIC METHOD

Aim : An experiment to demonstrate method of science.

Science is a way of recognising and solving problems and finding answers to the questions arising out of observation, study and experimentation. This uncovers new facts and establishes new concepts or hypotheses. The *scientific methods* include :

1. To define the problem (i.e., DEFINITION)

The first step in scientific studies is to recognise or understand the problem and to make a clear statement.

2. To collect informations relating to the problem (i.e., OBSERVATION)

Informations about the problem are collected from scientific books, journals, other written records to ascertain what is already known about the problem being investigated.

3. Formulation of hypothesis (i.e., HYPOTHESIS)

Hypothesis is the proposed solution for a problem, based on all available informations. It is just a speculation or assumption, as yet unproved. It is sometimes called the **'working hypothesis'**.

4. To test the hypothesis (i.e., EXPERIMENTATION)

The proposed hypothesis is tested :

(*i*) Through controlled scientific experiments ;

(*ii*) Through additional accurate observations and investigations, or

(*iii*) By the combination of both.

When using the scientific experimental method of investigation, it is essential to maintain a **'control group'**. For this a separate group is observed under conditions identical with the experimental group, except one condition being examined is not applied to the control group.

5. Drawing logical conclusion (i.e., CONCLUSION)

If conducted experiments and collected data favours the hypothesis, it is accepted ; if not it is rejected. It might indicate that the hypothesis is correct, but the collected data were inaccurate, incomplete or incorrectly interpretted. In some cases, the original hypothesis is neither accepted nor rejected. It is changed to fit new facts.

6. Publication of results

Knowledge gained through scientific investigations is passed on to others through printed material like magazines, journals or computers.

If carefully and accurately utilised a scientific method can be a blue print—from which scientific knowledge is built.

Problem 1 : DISCOVERY OF PENICILLIN

In order to illustrate the steps in a scientific method, let us take *'Alexander Flemings Discovery of Antibiotic Penicillin'*.

1. Observation :

Alexander Fleming observed—when a spore of mould—*Penicillium* accidently dropped in a plate culture of bacteria, the mould growth prevented the growth of bacteria in the plate culture.

2. Definition of Problem :

Growth of mould—*Penicillium* has prevented the growth of disease-producing bacteria in culture.

3. Hypothesis :

Fleming hypothesized that mould *Penicillium* produced something which caused the death or prevented the rapid growth of disease causing bacteria. This can be useful in the treatment of bacterial diseases.

4. Experimentation :

Fleming experimentally tested his hypothesis. He conducted repeated experiments with plate cultures of some bacteria and introduced the same mould. He obtained the same results, recorded his data.

5. Conclusion :

Fleming organised and interpretted his experimental results and concluded that this mould did produce some antibacterial substance which prevented the growth of bacteria and killed them.

Problem 2 : LIGHT IS NECESSARY FOR PHOTOSYNTHESIS

Observation : Plants kept in dark for several days turn yellow and weak and do not show presence of starch. When same plants are put in light these turn green and give positive test for starch with iodine.

Hypothesis : Light is necessary for photosynthesis.

Experiment : Take a potted plant. Cut two pieces of black paper of equal size. Put one paper on the upper side and one on the lower side of a leaf of the potted plant. Clip them with the help of paper clips. Keep the set up in bright sunlight for few hours.

After few hours remove this leaf from the plant, boil in water and decolorise it with 95% ethanol. Test for starch with iodine solution. The portion of leaf covered with black paper does not turn purple while rest of the leaf becomes coloured and gives positive test for starch.

Conclusion : Starch has been synthesized in leaf portions which were uncovered and were able to receive light whereas the portion covered with black paper was not able to receive light and could not synthesise starch.

ORAL QUESTIONS

Q. 1. *What is science ?*

Ans. Science is systematic study of a problem and finding out reasonable answers to problems arising out of observation.

Q. 2. *What is the need of a control ?*

Ans. To test the working hypothesis for any problem the control is essential for comparison.

Q. 3. *Name any two scientific problems.*

Ans. 1. Cause of malaria.

2. Factors necessary for photosynthesis.

3. What is the composition of air inhaled and exhaled ?

□□

CORE EXPERIMENT 2
ADAPTABILITY

EXPERIMENT 2A

Aim : To study adaptability of cockroaches to drastic environmental changes.

Material Required :

Living cockroaches in a netted cage, and cockroach chloroformed.

Theory :

Over a million living species of animals have been discovered. The body organisation of each of them is remarkably adapted to their habitat. For example, fish are adapted to their aquatic habitat, frogs to their amphibious existence, insects, bats and birds to aerial existence. Cockroaches can be studied to observe this remarkable adaptability in their organisation to the dry and terrestrial existence.

Procedure :

1. Study various body parts in a chloroformed cockroach.

2. Dissect open to see its various organ-systems.

3. Study living cockroaches in the cage or in your home.

4. Observe its locomotion, flying, feeding and excretion.

5. Search for the 'Cocoon' of cockroach and study the structure.

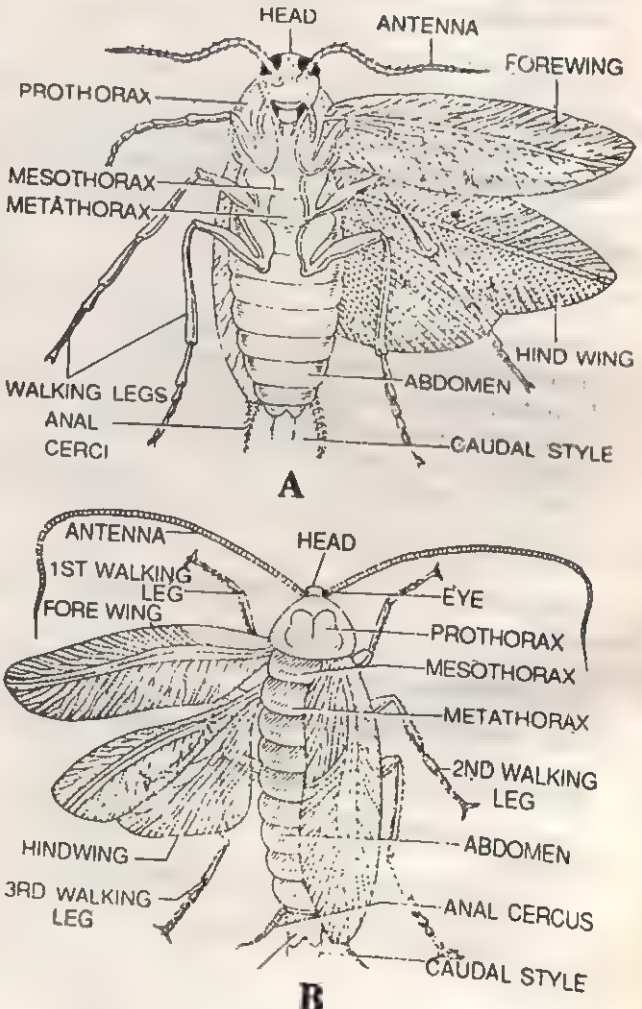


Fig. 4.1 : A—Dorsal view, B—Ventral view of cockroach.

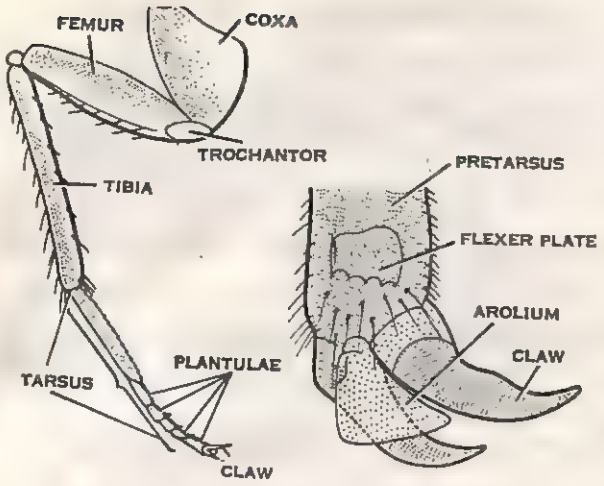


Fig. 4.2 : A - Walking leg of cockroach
B - A part of walking leg showing pad and claws that helps in walking on vertical surfaces

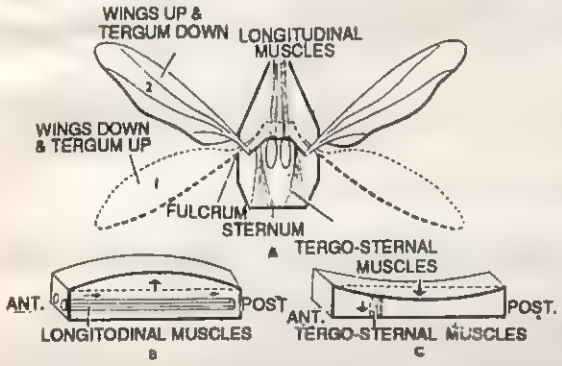


Fig. 4.3 : A—Wings and associated muscles that help in flight.
B & C—Function of tergosternal muscles during flight.

Observation :

1. **Body** is formed of twenty segments in all. It is differentiated into **head, thorax** and **abdomen.**

(*i*) **Head**—6 segmented - All segments fused.

(*ii*) **Thorax**—3 segmented Prosoma, Mesosoma, Metasoma.

(*iii*) **Abdomen**—11 segmented.

2. **Walking legs**—3 pairs, attached to three thoracic segments.

(*i*) Walking legs have joints where these can bend (jointed legs).

(*ii*) The end part of each leg is foot or **tarsus.** It has a pair of **claws** at its distal end. Claws enable insect to grip rough surfaces **clinging.**

(*iii*) **Sticky pads** on the undersurface of tarsus enable them to walk on smooth wall or ceiling.

(*iv*) Rows of **spines** are useful for defence.

3. **Wings**—2 pairs, attached to 2nd and 3rd thoracic segments :

These help in flight. These remain folded side ways abdomen on rest and stick out during flight.

4. **Spiracles**—These are a series of openings on either side of body. These let air into the body through special tubes, called **trachea.**

5. **Sense Organs**—These are present on head and are :

(*i*) Feelers or antennae—**tactile organs.**

(*ii*) **Compound** eyes and simple eyes or **ocelli-photoreceptors.**

(*iii*) Insect sees with compound eyes. The simple eyes or ocelli register changes in light intensity.

6. **Mouthparts**—Adapted for biting and chewing all types of organic food, this enables cockroaches to survive in all conditions.

7. **Cuticle or Exoskeleton**—Body is covered by impervious tough **chitin** with a thin layer of **wax.** It serves following functions :

(*i*) Waxy layer makes chitin water proof and avoids water loss from insect body in dry condition and enables cockroach to survive in water for quite some time.

(*ii*) Protects soft body parts against injury.

(*iii*) Provides attachment for the muscles.

Discussion : Organisation of cockroach presents such modifications which enables them to survive in water and on land and also to fly short distances.

There are :

1. Structure of walking legs enables cockroaches to walk on vertical surfaces and live in manholes.

2. Wings help in flight and enables cockroaches to move away swiftly from the enemy.

3. Long feelers or **antennae** help in locating food or enemy.

4. Omnivorous feeding habit helps in surviving under all possible areas.

5. Thick waxy exoskeleton protects them against dessication and enables them to live on land.

6. Absence of respiratory pigment is compensated by network of **tracheal system** which distributes oxygen to every cell of the body.

7. Jointed legs and segmented body helps in bending of legs at different levels and of relative movement of body parts.

8. **Malpighian tubules** open into the alimentary canal. These help in reabsorption of water and avoid loss of water.

9. Its compound eyes enable to see in dark also.

ORAL QUESTIONS

Q. 1. *Why is insect cuticle described as exoskeleton ?*

Ans. The chitinous covering over insect body is tough and supportive. It provides attachment to body muscles and helps in locomotion similar to vertebrate skeleton (bones) which provide attachment to the muscles and help in locomotion. Being outside the body it is called **exoskeleton** and vertebrate skeleton being internal structure is called **enoskeleton.**

Q. 2. *What is chitin ?*

Ans. Chitin is a mucopolysaccharide.

Q. 3. *What is moulting or ecdysis ?*

Ans. Moulting is the phenomenon of casting off old chitinous exoskeleton and its replacement by a new and larger one so as to compensate increase in body size.

Q. 4. *Why the exoskeleton in cockroach is so smooth and shining ?*

Ans. Because of an outer thin layer of wax on the exoskeleton.

Q. 5. *What are sclerites ?*

Ans. Sclerite is a ring of exoskeleton enclosing one segment. It is formed of four exoskeletal plates: dorsal **tergite**, ventral **sternite** and two lateral *pleural plates.*

Q. 6. *How are the sclerites of various segments connected together ?*

Ans. By arthrodial membrane. At these points exoskeleton can bend.

Q. 7. *How is cockroach able to walk on vertical surfaces ?*

Ans. On the under surface of tarsus are sticky **pads.** These enable insect to walk on smooth vertical wall or upside down on the ceiling without falling.

Q. 8. *What is spiracles ?*

Ans. Spiracles are openings of tracheae outside.

Q. 9. *How many spiracles are present in cockroach ?*

Ans. Total 10 pairs of spiracles : 2 pairs of **thoracic spiracles** and 8 pairs of **abdominal sepiracles.**

Q. 10. *In insects blood is without respiratory pigment. How does transport of gases occur in them ?*

Ans. In insects, tracheal system remifies in the body and its fine branches (tracheoles) penetrate dee into the tissue. Exchange of gases occurs directly between the tissue fluid and the air in tracheoles.

Q. 11. *What is the total number of walking legs in insects ?*

Ans. Three pairs of walking legs.

Q. 12. *What is the use of simple and compound eyes in insects ?*

Ans. (*i*) **Compound eyes** form image of the objects and are organs of sight.

(*ii*) **Simple eyes** or **ocelli** register changes in the intensity of light.

Q. 13. *What are various functions of exoskeleton in insects ?*

Ans. (*i*) Protection of soft body parts.

(*ii*) Provides proper shape.

(*iii*) Provides surface for attachment of muscles and help in locomotion.

(*iv*) Protects against dessication by checking evaporation.

(*v*) Hard chitinized mouth parts help in biting and chewing.

Q. 14. *What are compound eyes ?*

Ans. Compound eyes are composed of numerous visual units called **ommatidia**, which are separated by pigment sheath.

Q. 15. *List three ways insects prevent water being lost from their bodies.*

Ans. (*i*) Impervious cuticle with outer waxy layer checks evaporation from body surface.

(*ii*) Liquid waste collected from the blood is poured into alimentary canal where water is absorbed back into the blood. Cockroach excrete **uric acid** in solid form.

(*iii*) Spiracles are kept closed as much as possible.

Q. 16. *What are respiratory organs of insects ?*

Ans. Tracheae.

Q. 17. *Why is it advantageous to an insect to have valves guarding its spiracles ?*

Ans. (*i*) Valves close spiracles and check evaporation of water from body fluid.

(*ii*) Valves regulate the amount of air getting in tracheae.

(*iii*) Valves check the entry of unwanted material inside the tracheae.

Q. 18. *What is the use of eggs being laid inside an egg case or ootheca ?*

Ans. Ootheca is hard and chitinous which protects eggs. It can be deposited on any dry place. Thus it is an adaptation to terrestrial existence.

□□

CORE EXPERIMENT 3

COMPOUND MICROSCOPE

Aim : Study of parts of compound microscope, its proper use and maintenance.

Material Required :

Compound microscope, its case, slides, tissue paper, muslin cloth.

Study of Compound Light Microscope

What is a microscope ?

A microscope (Gr. *micros*, small + *scopien*, watch) is a combination of magnifying lenses, specially designed for the study of objects too small to be seen by naked eye.

Invention of Compound Microscope : ZACCHARIAS JANSSEN and his son HANS in Middleburg, Holland (1590) invented first compound microscope. ROBERT HOOKE (1665) with the help of compound microscope observed cell.

Types of Microscopes :

1. Simple light microscope
2. Compound light microscope
3. Ultraviolet microscope
4. Phase contrast microscope
5. Electron microscope
6. Oil Imersion microscope
7. Dark-Field microscope

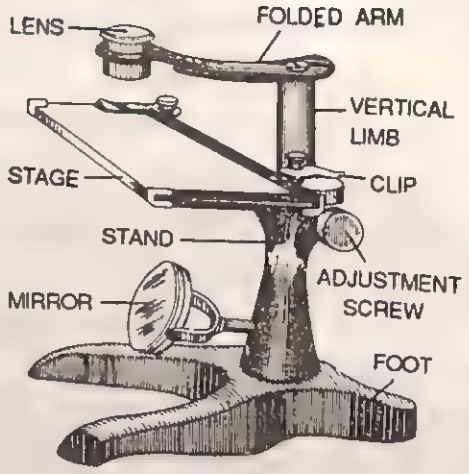


Fig. 5.1 : Diagram of a simple light microscope (Dissecting microscope)

Structure of Compound Light Microscope :

Compound light microscope is used in the class room by students to study :

(*i*) Structure of minute organisms.

(*ii*) Sections of different parts of organisms.

(*iii*) Histological details of different body organs.

Principle :

Magnification is obtained by the combination of two lens systems :

1. **Objective lens :** Lies close to the object and forms its real inverted image.

2. **Eye piece or ocular lens :** Remains close to the eye, forms virtual image of the image formed by objective lens. The two lens systems are placed one above the other in a vertical **body tube** at a calculated distance so that the image formed by objective is magnified by the eye piece.

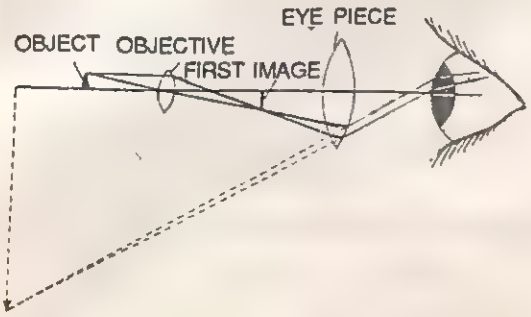


Fig. 5.2 : Formation of image by compound microscope

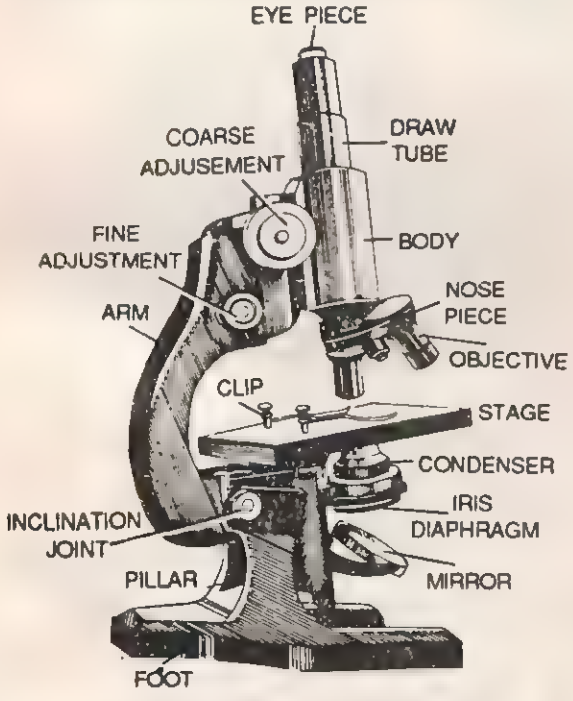


Fig. 5.3 : A compound microscope

Magnification :

$$\text{Magnification of compound microscope} = \text{Magnifying power of objective} \times \text{Magnifying power of eye piece}$$

$$100\text{ X} = 10\text{ X} \times 10\text{ X}$$

The magnifying power is written on the objective tube. There are two objectives :

(*i*) Low power objective : 10 X

(*ii*) High power objective : 45 X

The magnifying power of eye piece is usually 10 X, but we have 5 X and 15 X eye pieces also.

Various parts of a compound microscope and their functions are given in a tabular form below :

S. No	*Parts*	*Function*
1.	**Stand or Base**	Rests on the table.
2.	**Arms or limb**	Body tube is attached to its upper end by rack and pinion mechanism ; can be moved up and down by two knobs.
3.	**Body tube**	Carries eye piece attached to its upped end and a **nose** piece attached to its lower end.
4.	**Nose piece** (a circular disc)	is attached to the lower end of body tube ; bears 2 or 3 holes for the attachment of objectives of different magnifying powers ; can be rotated to bring desired objective in position.
5.	**Objective**	(*i*) Low power objective 10X (*ii*) High power objective : 45X Consists of **concavo-convex lens**, forms image of the object.
6.	**Eye piece**	Consists of **Plano-convex lens** magnifies image formed by the objective.
7.	**Coarse adjustment (Large knob)**	Moves the body tube up and down for proper focussing while examining under low magnification.

8.	**Fine adjustment (Small knob)**	Used for more accurate focussing while examining under high magnification.
9.	**Stage**	For placing the slide.
10.	**Stage clips**	For fixing the slide on the stage while examining under the microscope.
11.	**Condenser and Substage**	Lies below the stage ; condenses the light rays on the object.
12.	**Diaphragm**	Attached to substage, used to control the amount of light falling on the object.
13.	**Mirror (Plano-concave)**	(*i*) Plane side focusses sun-light rays on the object through condenses. (*ii*) Concave mirror is used to focuss light rays from the lamp.

SETTING THE MICROSCOPE

1. Take out the microscope from the box and place it gently on the working table, keeping the arm towards you and stage away. The base should be 3"- 4" away from the edge of the table.

2. Locate the various parts and check the damage or loss of part if any.

3. Clean the body and stage of microscope with some clothpiece and the lenses with lens paper.

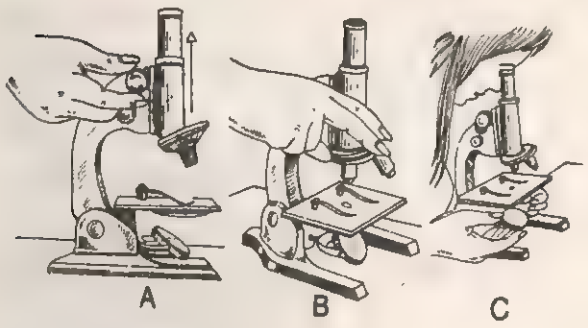


Fig. 5.4 : Setting of a compound microscope.

4. Using the coarse adjustment raise the body tube about an inch above the stage.

5. Rotate the nose piece of low power objective and hear the click. This indicates that the objective is brought in line with the body tube. While rotating, be careful that the objective is not in contact with the stage.

6. Open the diaphragm of the condenser fully.

7. Look through the eye piece with your left eye but keep both eyes opened. Hold the edge of the mirror below the stage and tilt and turn the mirror towards a light source and adjust its position so as to uniformly illuminated field.

FOCUSSING OF OBJECT UNDER THE MICROSCOPE

Focussing Under Low Magnification

1. Place the slide to be examined on the stage of the microscope and move it till the object comes in the centre of the hole of the stage.

2. Lower the body tube with the coarse adjustment until the low power objective comes close to the cover glass or until it cannot be moved down.

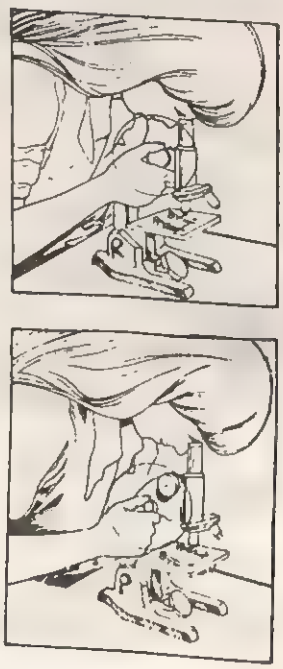


Fig. 5.5 : Focussing with a compound microscope : (a) in low magnification, (b) in high magnification.

3. Look through the eye piece and raise the objective with coarse adjustment until the object is visible.

4. Make the focus sharp with fine adjustment of microscope.

Focussing Under High Magnification

If the object is to be viewed under high power, do not try to focus it directly under high power. First focus it under low power and then change the high power objective, and adjust focus by using fine adjustment to get sharp image.

While focussing under high power never use coarse adjustment

CARE AND PRECAUTIONS

Microscope is a delicate instrument. It should be handled with all care and precautions. Some of them are being listed here :

1. Take out the microscope from its case only when it is to be used and replace it immediately afterwards.

2. For lifting or removing from the box, hold the arm of the microscope with one hand and support the base with the other. Do not lift the microscope carelessly with one hand.

3. Place the microscope on the working table gently and at least $2\frac{1}{2}$" away from the table edge in order to prevent its accidental fall.

4. The arm of the microscope should always be towards you and the stage away from you.

5. You are supported to know all parts of microscope. Check all its parts before use. In case of damage or absence of any part immediately inform the teacher-in-charge.

6. Clean different parts of the microscope before use.

7. Avoid the tilting of the microscope, keep it in upright position.

8. While focussing light on the object do not allow the direct sun-rays to strike the mirror.

9. Use plain mirror for natural day light and concave for artificial light.

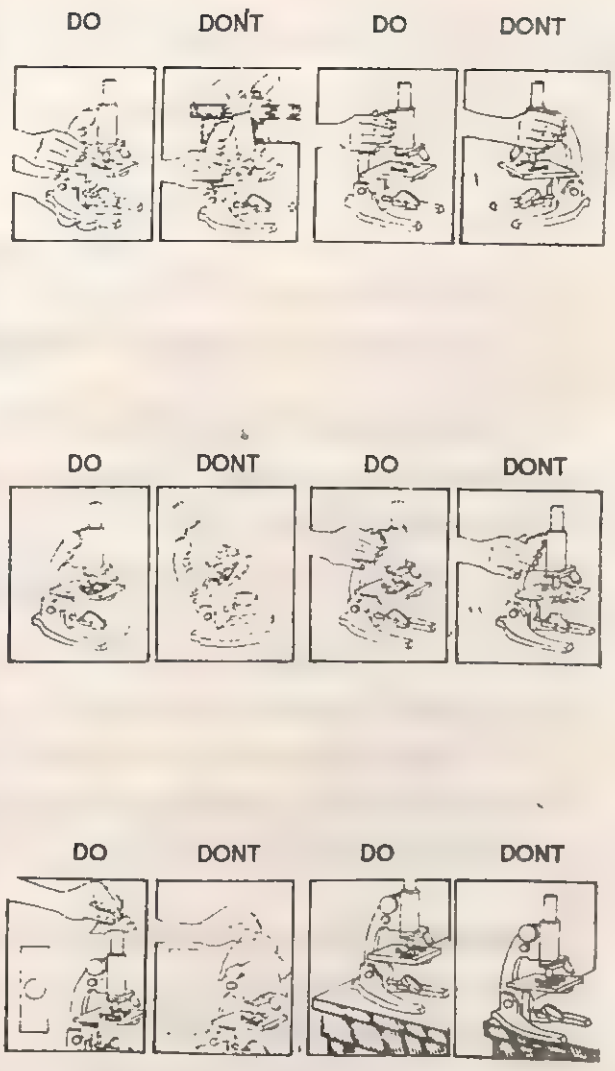


Fig. 5.6 : Precautions while handling compound microscope

10. The stage should always be dry and clean.

11. Do not put wet slide on the stage and never observe any object dry and uncovered. The material to be observed should be properly mounted and covered with cover glass.

12. Take extreme care that the objective does not touch the cover glass.

13. Move the screw of rough or fine adjustment slowly and carefully, otherwise the objective will run into the slide, break the coverslip or damage the object. This might even break the slide.

14. The lenses should never be touched or cleaned with hand. Always wipe them with lens paper or muslin cloth.

15. Clean the objective lens with lens paper after use.

16. After use, make the objective free and lower the body piece. Transfer it into its box and keep it in its position.

17. While observing through microscope, keep both eyes open.

ORAL QUESTIONS

Q. 1. *What is a microscope ?*

Ans. A microscope is a combination of magnifying lenses, for the study of objects too small to be seen by naked eye.

Q. 2. *Who invented the first compound microscope ?*

Ans. **Zaccharias Janssen** (1590) invented the first compound microscope.

Q. 3. *What is magnification power ?*

Ans. Magnification power of a compound microscope is the multiplication of magnifying powers of objective and eye piece.

Q. 4. *What is the magnification power of a laboratory compound microscope used by students ?*

Ans. (*i*) Magnification in low power : $10\ X \times 10\ X = 100\ X$

(*ii*) Magnification in high power : $10\ X \times 45\ X = 450\ X$.

Q. 5. *What is the difference between simple and compound microscope ?*

Ans. In **Simple microscope** : There is only one lens system which forms an upturned image of the object.

In **Compound microscope** : There are two lens systems :

(*i*) Objective lens system.

(*ii*) Ocular lens system (eye piece).

Image formed by the objective acts as object for the ocular lens. Thus, the final image is not upturned.

□□

CORE EXPERIMENT 4
STUDY OF ANIMAL AND PLANT CELLS

Preparation of temporary stained slides of *animal tissues* (cheek squamous epithelial cell of man/skin squamous epithelial cells of frog) and *plants* (onion bulb peel/Tradescantia staminal hair, algae) and highlight *similarities and differences* in gross structure.

EXPERIMENT 4-A.
TEMPERORY MOUNTS OF ANIMAL CELLS

Aims : **To prepare temporary stained slides of animal tissues.**

(*a*) Cheek squamous epithelial cells of man.

(*b*) Skin squamous epithelial cells of frog.

Material Required :

Equipments	Chemicals
Slides	Methylene blue
Coverslips	Glycerine
Tooth-picks	
Needle	**Animal**
Brush	Living or dead frog.
Microscope	

Procedure :

Experiment 1 :

Cheek Squamous Epithelial Cells of Man

Collection of Material :

1. Take a clean and dry slide. Put a drop of mammalian saline .9% Nacl.

2. Clean your mouth with water to wash off food particles if any.

3. Gently scrap the inside of cheek with the broad end of tooth pick. Observe the slimy pale white matter sticking to it.

4. Put this matter in the saline drop and spread it with the help of needle.

Staining and Mounting

5. Place one or two drops of methylene blue on the material.

6. Put a coverslip after about one minute.

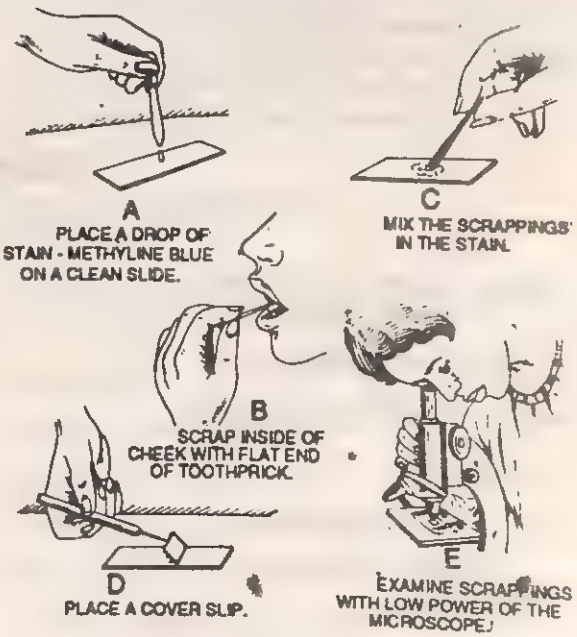


Fig. 6.1 : Steps in mounting squamous epithelium from cheeks.

Observation :

Observe under low magnification and then under high power of compound microscope. Slide shows following characters—

1. Cells are flattened and polygonal or roughly polygonal.

2. *Nucleus* is oval or spherical and lies in the centre of cell.

Draw its diagram and label its parts.

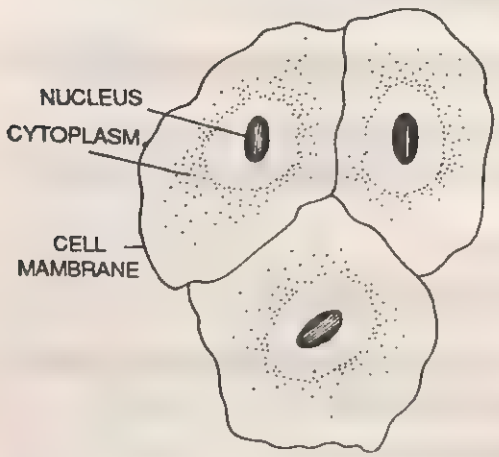


Fig. 6.2 : Diagram showing squamous epithelial cells from man's cheek.

Precautions :

1. Slide and coverslip must be clean and dry.

2. The collected material shall be spread out uniformly in the saline drop.

3. The saline and also the stain shall not spill from the slide. Therefore use only few drops of stain.

4. Blot off the excess of stain from the slide before observing under the microscope.

5. Material and coverslip shall be in the centre of slide.

6. Use microscope carefully.

Experiment 2

Skin Squamous Epithelial Cells of Frog

Procedure :

1. Place a freshly chloroformed frog in water or take a preserved frog.

2. Scrap gently the skin from the back of frog with the help of sharp scalpel.

3. Put a drop of **eosin** or **methylene blue** stain on a clean and dry slide.

4. Dip the tip of scalpel in the stain drop to deposit the scraping off the scalpel in the stain.

5. Spread the scrap uniformly and cover with a coverslip.

6. Examine under the microscope.

Observations :

1. Cells of squamous epithelium are flattened polygonal cells placed edge to edge.

2. Nucleus lies in the centre of the cell.

3. Cell cytoplasm is without any vacuole and cell wall.

Precautions :

1. Use as little material as possible.

2. Avoid overlapping of tissue.

EXPERIMENT 4-B.
TEMPORARY MOUNT OF PLANT CELLS

Aim : Preparation of temporary stained mount of plant cells :

(*a*) Cells of Onion bulb peel.

(*b*) Staminal hair of Tradescantia.

(*c*) Algal cells.

Experiment 1 :

CELLS OF ONION BULB PEEL

Material Required :

Equipments	Chemicals
Slides	Iodine Solution
Coverslips	Stain-safranin
Needle	Glycerine
Blade or Razor	Material
Brush	Onion
Microscope	Tradescantia flower
Watch glass	Algae *Spirogyra*

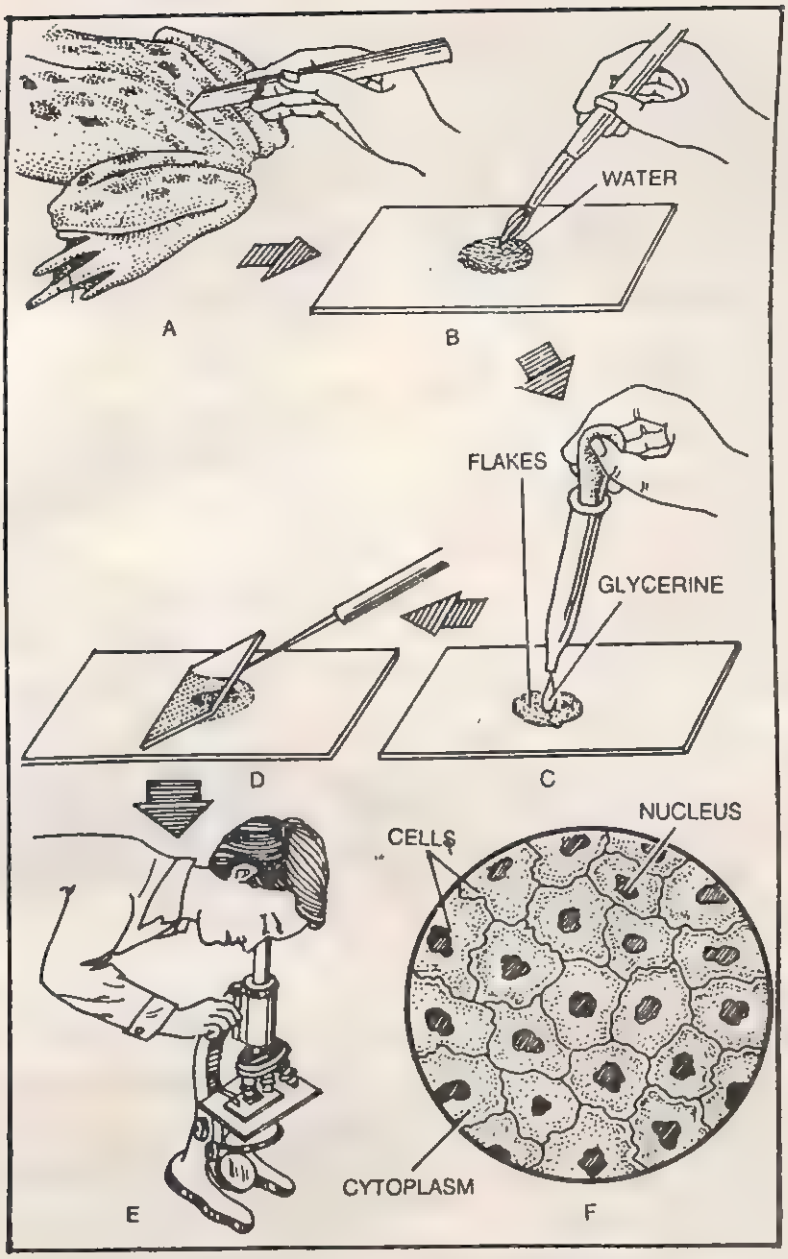


Fig. 6.3 : Mounting of squamous epithelium of frog.

Procedure :

1. Cut onion into four pieces.

2. Take an inner leaf from one of these pieces.

3. Cut $\frac{1}{4}$ inch squares on the inner side of leaf with a razor blade.

4. Snap the leaf backward.

5. Remove one square of thin onion skin.

6. Mount this piece in stain-safranin on a clean slide.

7. Cover with a clean coverslip and study under the microscope.

Observation :

Observe following structures :

1. Cells are roughly rectangular.

2. There is a *cell wall* outside plasma membrane or cell membrane.

3. The *cytoplasm* forms, a thin peripheral layer.

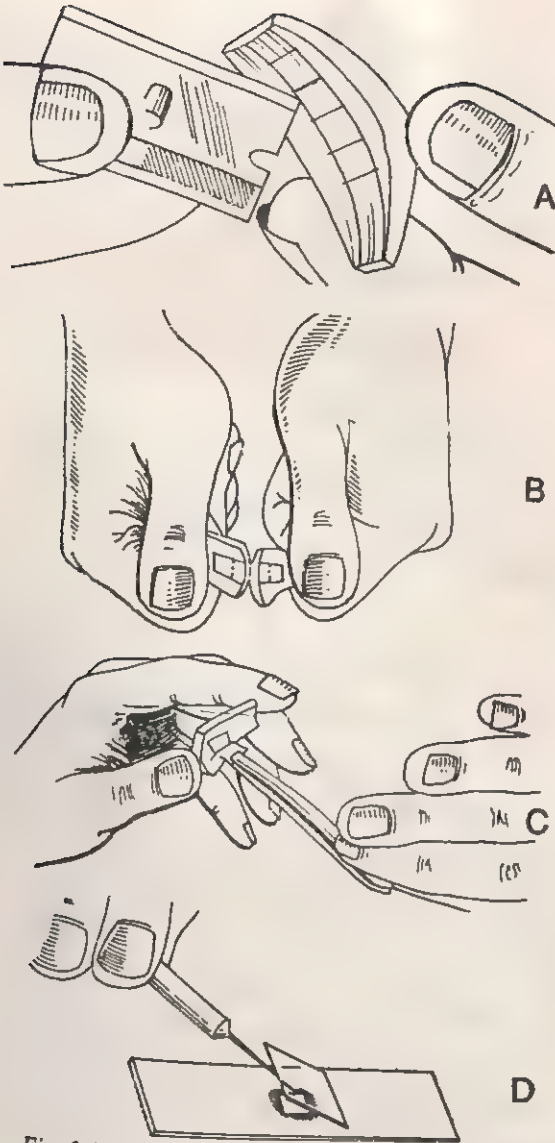


Fig. 6.4 : Diagram showing steps in the mounting of cells of onion bulb peel.

4. Most mature plant cells have a large, fluid-filled space—the *vacuole*.

5. Vacuole is filled with *cell sap*.

6. Cell cytoplasm contains cell organelle. These include plastids or chloroplasts.

Experiment 2 :

TRADESCANTIA : STAMINAL HAIR

Procedure :

1. Remove one stamen from a fresh *Tradescantia* flower.

2. Observe stamen under a dissecting microscope or with a hand lens.

3. Pluck one staminal hair from the stamen and put it on a clean glass slide in a drop of water.

4. Place a drop of glycerine with the help of a dropper and cover with a coverslip.

5. Observe temporary mount under low and then under high magnification.

Observation :

1. Staminal hair of *Tradescantia* are multicellular.

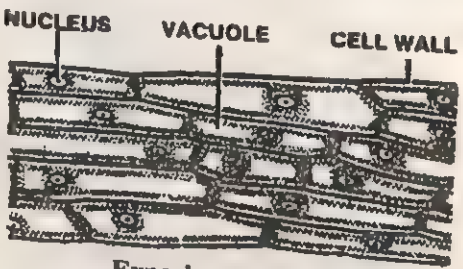
2. Each cell consists of

(*i*) a *cell wall* (*ii*) a *nucleus*

(*iii*) vacuolated granular *cytoplasm*.

3. Granular cytoplasm exhibits movement in clockwise or anticlockwise direction.

4. Draw diagram of some Tradescantia cells and indicate cytoplasmic movement with the help of arrows.



Experiment 3 :

CELLS OF ALGAE
(SPIROGYRA—POND SILK)

Aim : Study of Spirogyra cells.

Material :

Slide
Coverslip
Needle
Watch glass
Breaker
Bottle

Spirogyra

Collection of Material

Cells of Algae (*Spirogyra*—pond silk) and green threads from fresh water pond or pool or road-side ditch in a beaker.

Procedure :

1. On a clean slide put a drop of water and place a little scum from the collected pond water.

2. Tease a little to separate the threads.

3. Put coverslip and study under low magnification of compound microscope.

4. Observe carefully and draw a labelled diagram.

Observations :

1. Each algal filament is formed of a number of rectangular cells arranged lengthwise.

2. Each cell has an (*i*) outer *cell wall*, (*ii*) a centrally placed *nucleus*, (*iii*) cell *cytoplasm* forming strands that extend from nucleus to cell wall, (*iv*) a spirally coiled band-shaped *chloroplast*.

Similarities Between Plant and Animal Cells :

All plants and animals are formed of cells. All cells have certain things in common as in Fig. 6.7.

(*i*) Every cell is surrounded by a cell membrane or plasma membrane.

(*ii*) Every cell has a nucleus.

(*iii*) Every cell has cytoplasm that surrounds the nucleus and contains various cell organelle.

Differences between plant and animal cells.

(*i*) Plant cells have a thick *cell wall* not found in animal cells.

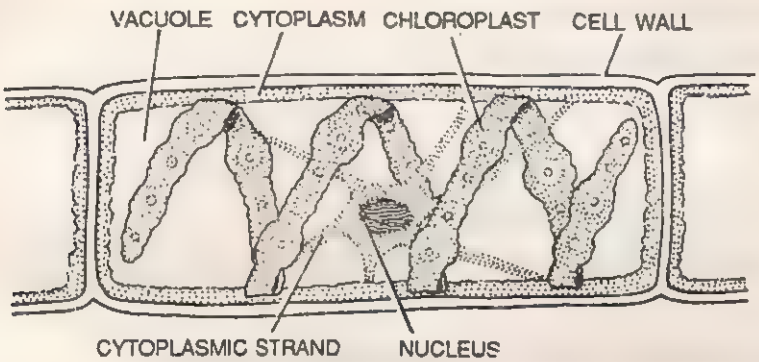


Fig. 6.5 : Spirogyra under low magnification.

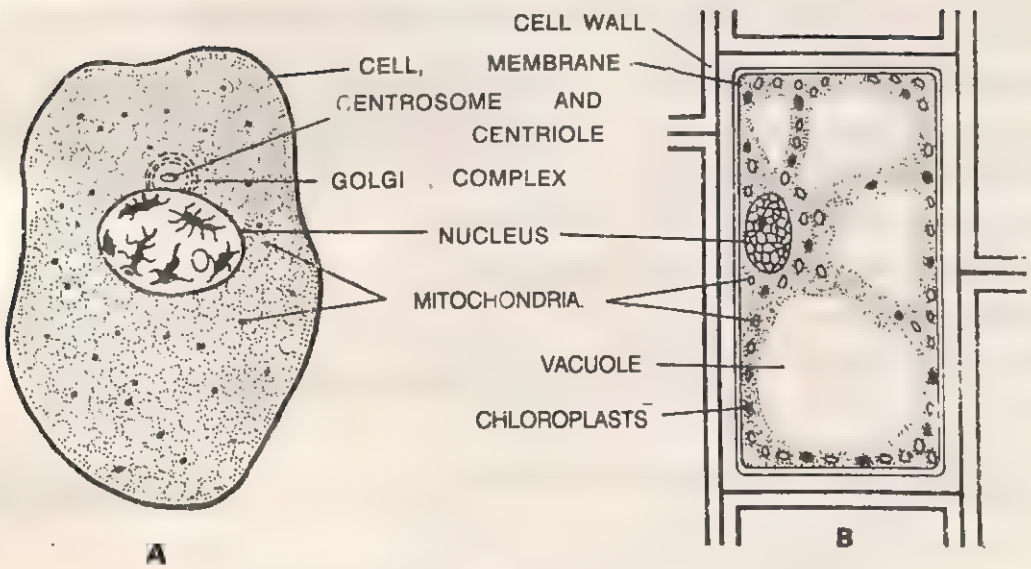


Fig. 6.6 : Diagram showing differences in a plant and an animal cell.

(*ii*) The *nucleus* in animal cells is usually central while in plants, the nucleus lies on one side.

(*iii*) *Cytoplasm* is not vacuolated in animal cells. It contains one large or a few small vacuoles in plant cells.

(*iv*) *Chloroplasts* (green coloured bodies) are found in plant cells but not in animal cells.

TABLE

Characteristics	*Plant Cell*	*Animal Cell*
1. Cell wall	+	–
2. Cell membrane	+	+
3. Vacuole	+	–
4. Plastids	+	–
5. Centriole	–	+
6. Nucleus	+	+

ORAL QUESTIONS

Q. 1. *What is a tissue ?*

Ans. Tissue is a group of identical cells carrying out similar function.

Q. 2. *What kind of tissue lines the blood vessels ?*

Ans. Epithelial tissue—called *endothelium.*

Q. 3. *Which type of cells protect and cover the body ?*

Ans. Epithelial tissues.

Q. 4. *What is a cell ?*

Ans. A cell is the unit of structure and function.

Q. 5. *What are the basic differences between plant and animal cell ?*

Ans. Refer Text.

Q. 6. *What is the basic difference between prokaryotic and eukaryotic cells ?*

Ans. In *eukaryotic cells* distinct nucleus is present. It has a *nuclear membrane* that separates the nuclear material from cytoplasm.

In *prokaryotic cells* the nuclear membrane is absent. The nuclear material (a single chromosome) lies in the cytoplasm.

Q. 7. *What is the difference between bacterial chromosome and human chromosomes ?*

Ans. Bacterial chromosome is formed of a single long molecule of double helical DNA whereas, human chromosomes are formed of nucleoproteins.

Q. 8. *What cell structures are visible under light microscope ?*

Ans. Cell membrane, cytoplasm, nucleus and chloroplasts.

Q. 9. *What are chloroplasts ?*

Ans. Chloroplasts are plant cell organelles which have chlorophyll and carry out photosynthesis.

Q. 10. *What is the nature of cell wall ?*

Ans. Cell wall is non-living. It is secreted by the cell and is formed of cellulose, hemicellulose, lignin and pectic compounds.

Q. 11. *What is the use of vacuole in a plant cell ?*

Ans. In plant cells vacuoles maintain turgidity and store food material and waste products.

Q. 12. *What are those structures in the cell which release energy for functioning and maintaining the cell ?*

Ans. Mitochondria.

Q. 13. *What are those cell organelle which are concerned with converting solar energy into chemical energy ?*

Ans. Chloroplasts.

Q. 14. *Plastids without any pigment are called ?*

Ans. Leucoplast.

□□

CORE EXPERIMENT 5
COLOUR TESTS OF ORGANIC SUBSTANCES

EXPERIMENT 5-A.
COLOUR TESTS FOR GLUCOSE, SUCROSE, STARCH, FAT AND PROTEIN

Aim : (a) To show presence of glucose, sucrose, starch, fat and protein in seeds (gram, peanut).

(b) To show presence of glucose, sucrose, starch, fat and protein in seeds and other plant tissues.

COLOUR TESTS FOR CARBOHYDRATES

Aim : Colour tests for glucose, sucrose and starch

Material Required :

Equipment	Reagents
Test tubes	Bendicts reagent
Test tube stand	Fehling solution
Test tube holder	Barfoed reagent
Spirit lamp or Burner	Molisch's reagent
Test tube holder	Conc. H_2SO_4
Pipette	Phenyl hydrazine
	Selivanoff's reagent
	Picric acid

Solutions :

Freshly prepared solutions of

Glucose
Sucrose
Starch

A. General Tests for Carboydrates :

1. Moliseh's Test :

Procedure : Take 5 ml. of test solution (glucose, sucrose or starch) in a test tube and add 2 drops of Molisch's reagent. Shake thoroughly. Take 3 ml. of conc. H_2SO_4 in another test tube, and add this to the test solution by gently pouring the acid along the side of the test tube in such a manner that two solutions do not mix. Acid being heavier forms a separate layer at the bottom of the test tube.

Result : A pink or *reddish violet* ring appears at the interface of two solutions.

Chemistry : Acid react with carbohydrate forming furfural or furfural derivative, which reacts with α-naphthol of Molisch's reagent forming reddish violet colour.

In high concentration of organic substances in the test solution, red instead of the reddish violet colour appears.

B. Colour Test for Reducing sugars (Monosaccharide)

2. Benedict's Test :

Procedure : Take 5.0 ml. of *Benedict's reagent* in a dry tube and add 0.5 ml. of test solution. Mix well, boil for two minutes and cool under tap water.

Result : Presence of sugar is indicated by the formation of *red, brown, yellow, or yellowish green* precipitate. The colour depends upon the concentration of sugar.

Chemistry : The colour is formed due to the repuction of cupric ions of Benedict's solution to curous oxide. The reduction is affected by the *reducing aldehydric or ketonic groups* in the sugar.

3. Fehling's Test :

Procedure : Take 1 cc. of *Fehling's solution* in a dry test tube. Add 4 cc. of water and boil to ascertain that Fehling's solution does not give brownish precipitate. If no precipitate is obtained, add 1.00 ml. of test solution and boil the mixture.

Result : Appearance of *brownish, reddish or yellowish precipitate* indicates the presence of reducing sugar.

Chemistry : Mechanism of reaction is same as in case of Benedict's test.

4. Barfoed's Test :

Procedure : Take about 5 ml. of *Barfoed's reagent* in a test tube and add about 0.5 ml. of test solution. Mix and heat to boiling.

Result : Appearance of *red precipitate* of Cu_2O within 30 seconds shows the presence of reducing monosaccharides.

Chemistry : Barfoed's test is used to confirm the presence of reducing monosaccharides. The test is unsuitable for the detection of reducing sugars in urine or the fluid that contains chloride ions.

5. Picric Acid Test :

Procedure : Take about 5 ml. test solution (sugar solution) and mix about 3 ml. of saturated *picric acid* solution and 1 ml. of 10% sodium carbonate and warm.

Result : A *red colour* develops in presence of *reducing sugar.*

Chemistry : The reducing sugar reduces the alkaline solution of *picric acid* to red *picramic acid.*

$$C_6H_5OH\,(NO_2)_3 \rightarrow C_6H_5OHNH_2\,(NO_2)_3$$

Picric acid Picramic acid

C. Colour Tests for Ketohexoses (Monosaccharide)

6. Seliwanoff's Test :

Procedure : Take 5 ml. *of Seliwanoff's* reagent in dry test tube and add 5 drops of test solution. Heat till boiling.

Result : If a ketosugar (fructose) is present, a *red colour* appears within 30 seconds of boiling. The test is also given by sucrose, which hydrolyses to yield free fructose.

D. Colour Tests for Reducing Dissacharides (Sugar)

7. Fearson's Test :

Procedure : In a test tube take about 4 ml. of test solution and add 4 drops of 10% *methylamine hydrochloride.* Boil the contents for 30 seconds and add 4-5 drops of 20% sodium hydroxide to make the solution alkaline.

Result : A *yellow colour* appears, which *slowly turns red in presence of reducing dissacharides* (sucrose).

E. Colour Test for starch and other Polysaccharides

8. Iodine Test :

Procedure : Take about 2 ml. of the test solution or suspension in a test tube. Boil and cool it to room temperature. Add 2 to 3 drops of dilute iodine prepared in potassium iodide.

Result : Iodine gives different coloured compounds listed below :

(*i*) *Blue colour* indicates the presence of *starch.*

(*ii*) *Wine - red colour* indicates the presence of glycogen.

(*iii*) *Reddish blue* or *purple colour* indicates the presence of *dextrin.*

REAGENTS

1. *Iodine reagent*—Prepare a 2% solution of KI and add sufficient amount of iodine to colour it deep yellow.

2. *Benedict's qualitative reagent*—Dissolve 173 g. sodium citrate and 100 g. sodium carbonate in about 800 ml. of water. Pour through a folded filter paper and make upto 850 ml. Dissolve 17.3 g. copper sulphate solution slowly and with constant stirring into the carbonate citrate solution.

Make the volume to 1 litre. The solution is stable for long.

OBSERVATION TABLE :

Test Reagent	Solution A (Glucose)	Solution B (Sucrose)	Solution C (Starch)	Control	Inference
1. *Molish Test*	Formation of purple ring	Formation of purple ring	—	No colour	Carbohydrate present (General Test)
2. *Benedict's Test*	Yellow ppt	No ppt.	—	No colour	Reducing monosaccharide (glucose) present
3. *Fehling's Test*	Yellow or brownish ppt.	No ppt.	—	No change	Reducing monosaccharide sugar (glucose)
4. *Barfoed Test*	Red ppt. is formed after 5 minutes	Red ppt. is formed after 8 minutes	—	No colour	Reducing sugar present (glucose)
5. *Picric Acid Test*	A red colour	—	—	—	Reducing monosaccharide (glucose)
6. *Seliwanoff's Test*	—	Red ppt on boiling to hydrolysis of sucrose into fructose	—	—	Glucose absent sucrose or fructose present
7. *Fearson Test*	—	Yellow colour the changes to red	—	—	Reducing disaccharide (sucrose)
8. *Iodine Test*	—	—	Blue colour	—	Starch present

3. *Fehling's solution*—Fehling's solution is a mixture of copper sulphate solution and alkaline tartrate solution which are prepared as follows :

(*a*) *Copper sulphate solution*—34.65 g. $CuSO_4$ $5HO_2$ are dissolved in water and made upto 500 ml. with distilled water.

(*b*) *Alkaline tartrate solution*—125 g. KOH and 173 g. Rochelle salt are dissolved in water and made upto 500 ml.

To prevent deterioration, these solutions should be preserved separately in rubber stoppered bottles and are mixed in equal volumes when needed for use.

4. *Barfoed's reagent*—Dissolve 13.3 g. neutral, crystallized copper acetate in 200 ml. of water, filter if necessary and add 1.8 ml. glacial acetic acid.

5. *Seliwanoff's reagent*—Dissolve 0.5 g. resorcinol in 100 ml. of dilute (1 : 2) hydrochloric acid.

COLOUR TESTS FOR PROTEINS IN SOLUTION

Aim : Colour tests for proteins in solution

Material Required :

Equipment	Reagents
Test tubes	Biurate reagent
Test tube holder	Million's reagent 'a'
Test tube stand	and 'b'
Pipette	Conc. HNO_3
Spirit Lamp or Burner	NaOH

Test Solutions :

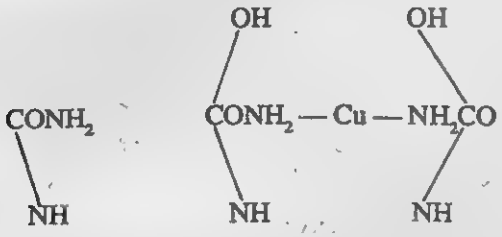
Prepare fresh protein solution or albumin soln. and perform one of the following tests. These colour tests are based on some chemical reactions used for protein identification.

1. Biuret Test :

Procedure : Take 2-3 ml. of protein solution in a clean and dry test tube and add 1 ml. of 10% NaOH and a drop of $CuSO_4$ solution. Mix well by shaking. If no colour appears add another drop of $CuSO_4$.

Result : Pink colour appears first which gradually changes to blue and purple.

Chemistry : In biuret test—CONH groups of protein molecules with copper and potassium molecules form a copper-potassium, biuret compound or biuret (potassium, cuperic hydroxide).



Biuret *Biuret Potassium* OH

Cuperic hydroxide

2. Millon's Test :

Procedure : Take 3 ml. of protein solution in a test tube, add 3-5 drops of Millon's reagent. Heat the solution to boiling.

Result : White or pink ppt. is formed which on further heating forms red solution, confirming presence of protein.

Chemistry : Proteins containing amino acids with benzene ring react with Millon's reagent. Millon's reagent is a solution of mercuric nitrate in nitric acid. It reacts with phenolic group.

3. Xanthoproteic Test :

Procedure : Take 2-3 ml. of protein solution in a test tube. Add slowly 1 ml. of con. HNO_3. Heat gently and observe colour change. Cool the solution under tapwater and add NaOH drop-by-drop.

Result : A white ppt is formed with HNO_3, which on heating turns yellow and finally dissolves to give yellow solution. On adding strong ammonia or 10% NaOH in excess the yellow solution turns orange.

4. Ninhydrin Test :

Procedure : Take in a test tube about 5 ml. of the dilute protein solution whose pH must be in the range of 5 to 7. Add to it 0.5 ml. of 0.1% solution of *ninhydrin*. The contents are heated to boiling for two minutes and then cooled.

Result : A *blue colour* is obtained in the presence of proteins.

The test is given positive by *proteins, peptones, peptides, amino acids and primary amines.*

Chemistry : Ninhydrin (1, 2, 3-inadanetrione hydrate) reacts with amines, particularly primary amines to give coloured products.

REAGENTS

1. Millon's reagent—One part of mercury (by weight) is dissolved with two parts (by weight) of HNO_3 (specific gravity 1.42) and diluted by two volumes of water.

3. COLOUR TEST FOR FATS

Aim : *Colour test for fats*

Material Required :

Test tubes	Castor oil or ghee
Paper	Groundnut or
Blotting Paper	Some other food stuff.

SUDAN - III

1. Grease Spot Test

(1) Crush the food stuff (ground nut etc.) to be tested. Rub it on a piece of paper. A translucent spot on the paper indicates presence of fat in the food stuff.

(2) With the help of a glass rod put a drop of oil or ghee on a plain paper. The appearance of a translucent spot indicates that the liquid is a fat.

(3) Extract fats or lipids from the food stuff by using organic solvent. Take 1 ml. of chloroform/Ether/Chloroform and Ethanol in the

ratio of 2 : 1. Add small quantity of food in it and shake vigorously. Pour the solution in a petridish. Dip a glass rod in the solution and put a spot on a plain paper. The paper becomes translucent.

2. Sudan Test :

(1) Take the crushed food (groundnut) to be tested in a petridish. Add small quantity of Sudan-III. Pinkish colour appears indicating the presence of fats.

(2) Take a few ml. of oil in a test tube. Add a few drops of Sudan-III. It gives red colour.

Result : Grease spot or red/pink colour indicates presence of fats or lipids.

EXPERIMENT 5-B.

Aim : To analyze different kinds of food stuffs for carbohydrates, proteins and fats.

Material Required :

(*i*) *Food stuffs* (Egg albumin, milk, potato, rice, wheat, grapes, groundnut, gram seed etc.)

(*ii*) *Glass ware*—Test tubes, test tube stand, test tube holder, spirit lamp / gas burner, watch glasses petridishes.

(*iii*) *Reagents*—Dil. HCl, 5% NaOH, Iodine solution, Benedicts reagent, Fehling solution, copper sulphate solution, Picric acid, Barfoed reagent, Seliwanoff's reagent ; Millon's reagent Ethanol etc.

Theory : The basic components of food stuffs are broadly separated into *carbohydrates*, *proteins*, *fats* and *lipids*. The colour tests for various components have been discussed in core experiment V-A.

Procedure : Perform colour tests to detect the presence of glucose, fructose, sucrose, starch, proteins and fats.

Observation : Record your observations in the table gives below. The presence of a particular component is indicated by + and absence by –

OBSERVATION TABLE

S. No.	Name of the Foodstuff or Name of the substance	Protein	Starch	Sucrose	Glucose	Fat
1.	A/ Grapes					
2.	B/ Groundnut					
3.	C					
4.	D					
5.	E					

Result : Foodstuff A contains following components:

1 ... 2 ... 3 ...

EXPERIMENT 5-C

TO DEMONSTRATE THE PRESENCE OF GLUCOSE, SUCROSE, STARCH, FATS AND PROTEINS IN DIFFERENT TISSUES OF PLANTS.

Aim : **Colour test to show presence of glucose, sucrose, starch, fat and protein in peanut/gram seed.**

Procedure :

1. The peanut/gram seed are soaked in water overnight to make them soft.

2. Grind them finely and prepare extract.

3. Filter and use filtrate for testing the presence of above mentioned organic compound.

4. The tests dicussed on pure solutions of these substances are carried out with the filtrate to test the presence of various organic constituents.

Observations : Record your observations in tabular form as on page 34.

Hint—Materials required to demonstrate the presence of these substances is listed below :

1. *For reducing sugar (glucose)* — (*i*) Leaves cleared of chlorophyll.
   — (*ii*) Fleshy leaves of onion bulb.
2. *For sucrose* — Same
3. *For starch* — Potato tubers or green leaves cleared of chlorophyll.
4. *For Protein* — Soyabean seeds.
5. *For Fats* — Cacti stems, eucalyptus leaves, or conifer leaves

ORAL QUESTIONS

Q.1. *Why monosaccharides (glucose, fructose) are called reducing sugar ?*

Ans. Because these contain either an *aldehyde group* (in glucose) or *keto group* (in fructose) which have reducing property.

Q. 2. *What confirmatory test you will carry out to demonstrate presence of glucose in a solution ?*

Ans. Benedict's test or Fehling test.

Q. 3. *How will you confirm the presence of Ketohexose (fructose) in a solution ?*

Ans. Seliwanoff's test (with Seliwanoff's reagent fructose gives red colour).

Q. 4. *Which tissue shall be used to demonstrate presence of protein ?*

Ans. Soyabean seeds or gram seeds.

Q. 5. *What is xanthoproteic test and for what is it used ?*

Ans. Xanthoproteic test is used to test presence of protein.

Q. 6. *How will you prepare Million's reagent ?*

Ans. One part of mercury (by weight) is dissolved in two parts of conc. HNO_3 (by weight) and is diluted by two volumes of water.

Q. 7. *What is the difference between reducing and non-reducing sugars ?*

Ans. *Reducing sugars* have a aldehyde or keto group free. *Non-reducing sugars* do not have free aldehyde or ketone group. These cannot reduce metallic ion. (Eg. sucrose).

Q. 8. *What is the basic difference between fats and oils ?*

Ans. (i) *Fats* are solid at room temperature. These are rich in saturated fatty acids. These have high melting point.

(*ii*) *Oils* are fluid at room temperature. These are rich in unsaturated fatty acids. These have low melting point.

Q. 9. *What are fats ?*

Ans. Fats are esters of fatty acids and glycerol.

Q. 10. *What are acidic and basic proteins ?*

Ans. *Acidic proteins* are enzyones or functional proteins of cell, *Basic proteins* are structural proteins of cells such as histones, which are structural proteins of chromation material of cell.

□□

CORE EXPERIMENT 6

Aim : Staining and observing microscopically the cell wall components such as cellulose, lignin, suberin and mucilage.

Material Required:

Equipments	Reagents
Watchglass	Iodine solution
Slides	Conc. HCl
Cover slips	Conc. H_2SO_4
Brush	KOH
Needle	Phloroglycinol
Razor	Zinc chloride
Microscope	Aniline sulphate
	Methylene blue
	Sudan-IV

Material
Cucurbita stem
Helianthus stem

Theory :

Cell wall is rigid outer layer in all plant cells that surrounds the cell membrane. It protects and provides rigidity and definite shape to the cell. Cell wall is absent in animal cells. Plant cell is formed of three layers

(*i*) *Primary wall*—formed of cellulose

(*ii*) *Secondary wall*—formed of Lignin or Suberin and present in woody tissue (*i.e.*, sclerenchyma and xylem)

(*iii*) *Tertiary wall* - formed of xylan.

A. Staining for Cellulose (Chlorenchymatous tissue)

Procedure : Cut thin transverse sections of cucurbita stem/*Helianthus* stem or take onion peel. Put them in a watch glass in water.

1. With Iodine :

(*i*) Place one section on a clean slide.

(*ii*) Add a drop of conc. H_2SO_4

(*iii*) After 20-30 seconds add 2-3 drops of **Iodine solution.**

(*iv*) Observe under microscope.

(*v*) *Dark brown or blue-black colour* appears in the cell-walls formed of cellulose.

Note : Iodine alone gives blue colour with starch and yellow colour with cellulose.

2. Staining with Congo-red :

(*i*) Sock sections in 10% aq. **Congo red** for 15 minutes in 10% HCl. The cellulose walls become red while the lignified walls remain unstained.

B. Staining for Lignin (woody tissue, xylem and sclerenchyma)

1. Staining with Phloroglycinol :

(*i*) Place one section of cucurbita stem on clean slide.

(*ii*) Put a drop of 1% *phloroglycinol* (alcoholic).

(*iii*) After two minutes add a drop of Conc. HCl.

(*iv*) Drain off excess of HCl and mount in glycerine.

(*v*) Cover with a coverslip and study under the microscope.

(*vi*) Note *red or pink colour* of lignified cell-walls (xylem vessels).

2. Staining with aniline sulphate :

(*i*) Place one section of cucurbita stem on a clean slide.

(*ii*) Put a drop of saturated **aniline sulpahte** or **aniline chloride.**

(*iii*) After two minutes add 2-3 drops of Conc. HCl.

(*iv*) Remove excess of HCl and mount in glycerine.

(*v*) Note *yellow colour* of the lignified cell-walls.

C. Staining for Suberin (outer layer of old stem or root)

(*i*) Cut a section from old stem cucurbita or *Helianthus.*

(*ii*) Mount in *chromic acid.*

(*iii*) Observe under microscope.

(*iv*) Cells with suberin coating develop deep yellow colour because of oil drops.

D. Staining for mucilage :

Mount sections of cycas, mustard or flax seeds in basic lead acetate.

S. No.	Substance to be tested	Source	Chemical Text	Result
A.	*Cellulose*	*Primary cell wall in Parechymatous tissue*	*Iodine*	*Yellow colour*
			Phyloroglycinol	*Red*
B.	*Lignin*		*Analine sulphate*	*Yellow Colour*
			Analine chloride	
			Safranine	*Red*
C.	*Suberin*		*Chromic Acid*	*Yellow*

ORAL QUESTIONS

Q. 1. *What is lignin ?*

Ans. Lignin is an amorphous yellow or brown substance of high molecular weight. It contains large proportion of aromatic rings. Its deposition on the cell wall makes the cells hard and woody. The tissue formed of lignified cells is called woody tissue (*e.g.*, xylem).

Q. 2. *Which cells have lignified cell walls ?*

Ans. Xylem vessels of vascular bundles and sclerenchyma cells have lignified cells walls.

Q. 3. *What is mucilage ?*

Ans. Mucilage is a colloidal material of complex nature secreted by some plants. This forms get with water or has adhesive properties like gum.

Q. 4. *Give few examples of mucilagenous substances ?*

Ans. Agar, gum, gelatin are mucilagenous.

Q. 5. *What is the difference between lignin and suberin ?*

Ans. Both lignin and suberin are non-living deposits in the cell wall. Lignin is found in the walls of xylem vessels and sclerenchyma cells while suberin is found on the walls of outer layer of cells of old stems or roots, making them impervious to water loss.

□□

CORE EXPERIMENT 7

ENZYMES—(THE BIOCATALYST)

(ACTION OF AN INORGANIC CATALYST M_NO_2 AND ENZYME (CATALASE) FROM POTATO/LIVER/PLANT TISSUES ON HYDROGEN PEROXIDE

Aim : To demonstrate that enzymes act as catalysts *Demonstration of action of an inorganic catalyst* (MnO_2) **and enzyme (catalase) from potato/liver/plant tissue on hydrogen peroxide** (H_2O_2).

Material Required :

Equipment	**Chemicals**
1. Beaker.	1. Hydrogen peroxide (substrate).
2. Test tubes.	2. Manganese dioxide (catalyst).
3. Test tube stand.	3. Water.
4. Test tube holder.	
5. Temperature bath.	
6. Thermometer.	

Material:

1. Potato pieces or Liver segments from freshly dissected rat (Source of enzyme catalase).

Theory :

Hydrogen peroxide gradually decomposes releasing water and oxgen. At room temperature the process of decomposition is very slow and evolution of oxygen cannot be demonstrated

$$2H_2O_2 \longrightarrow 2H_2O + O_2 \uparrow$$

Inorganic catalyst *manganese dioxide* (MnO_2) catalyses this reaction and release of oxgen increases considerably at room temperature as well as on higher temperatures. Even at high temperatures, it does not get denatured and is not utilised during the course of reaction. The evolution of oxygen is distinctly visible as bubbles. The number of bubbles increases with the rise of temperature indicating that at higher temperatures the reaction occurs more speedly.

Enzymes also act as catalyst. These catalyse various biological reactions at normal room temperature. The ideal temperature is 37°-38° C. Above this temperature enzyme activity decreases and falls with the increase of temperature. Above 60° C, enzymes get denatured and inactive. Since enzymes are produced or occur in living system and catalyse biological reactions, occurring within the cells or within body, these are described as *biocatalysts*.

Based on the type of reactions catalysed the enzymes can be:

(i) Oxidases.	(ii) Hydrolases.
(iii) Catalases.	(iv) Reductases.
(v) Invertases.	(vi) Demolases.

Enzymes are very specific in function. These act on specific substrates and catalyse only specific type of reactions. These act at specific pH, and temperature.

Liver or potato pieces are source of enzyme *catalase*. Catalase can cause decomposition of H_2O_2 similar to MnO_2 releasing oxygen which can be seen being evolved as bubbles.

Procedure :

1. Take one beaker. Fill it with water at 38°C. In winter water bath can be used for maintaining temperature of water at 38°C.

2. Take four clean test tubes. Mark them as A, B, C and D.

3. Put 2 ml. of H_2O_2 (hydrogen peroxide) in each tube and place them in the beaker.

4. Leave test tube A without adding anything. This forms control.

5. In test tube B add a pinch of MnO_2. In test tube C add few small potato pieces or crushed potato, and in test tube D add freshly cut liver piece.

6. In winter put all these test tubes in water bath at 38°C. In summer beaker may be filled with water at 38°C.

7. Leave them for a few minutes and observe.

Observations :

Bubbles are seen in test tubes B, C and D but not in test tube A.

OBSERVATION TABLE

S. No.	Test Tube No.	Observation	Inference
1.	A	No bubbles are seen	No oxygen is formed.
2.	B	Bubbles are seen	Oxygen is being evolved and escaping.
3.	C	—same—	—same—
4.	D	—same—	—same—

To test that gas evolved is oxygen, bring a burning match stick near mouth of each test tube. You will notice that except in test tube A in all other test tubes the burning stick burns more rapidly and brightly indicating presence of oxygen.

Conclusion :

Both MnO_2 and living matter (potato or liver pieces) act as catalyst and increase the speed of dissociation of H_2O_2.

Liver and potato are source of enzyme catalase which is responsible for the dissociation of H_2O_2.

Similarities between Inorganic catalysts and Enzymes.

1. Both enzymes and inorganic catalysts take part in the reactions but are not consumed. These remain unchanged after reaction (both chemically and quantitatively).

2. Both can be used and reused again and again.

3. Both are required in very small quantity.

4. These cannot initiate a reaction, but only enhance its rate by lowering activation energy.

Enzymes are described as *biocatalysts.*

(H_2O_2 is unstable compound and under normal conditions decomposes very slowly).

Differences between Inorganic catalysts and Enzymes

Inorganic catalysts	Enzymes
1. Usually simple mineral ions act as inorganic catalysts.	1. Proteins act as catalysts and have complex structure.
2. Can catalyse diverse reactions.	2. Catalyse only bio-specific reactions including specific substrate.
3. Can act at any pH and temperature.	3. Are very sensitive to change in pH and temperature.

ORAL QUESTIONS

Q. 1. *What are enzymes ?*

Ans. Enzymes are biological catalysts. These enhence the speed of reaction by lowering activation energy at normal body temperature. These are required in very small quantity and can be used over and over again without being used up in the reaction.

Q. 2. *Why are enzymes called biocatalyst.?*

Ans. Because these catalyse biological reactions occurring inside the cell or in the body of living being and these are synthesised by biological systems only.

Q. 3. *How enzymes differ from catalysts ?*

Ans. Enzymes are always proteins, more complex and are heat labile and pH specific. Catalysts are usually mineral ions, simple in structure and less sensitive to temperature and pH.

Q. 4. *Who discovered enzyme ?*

Ans. Enzyme was discovered by a German chemist EDWARD BUCHNER in 1897 from yeast extract.

Q. 5. *What are hydrolases ?*

Ans. Hydrolases are enzymes that hydrolyse or break down complex macromolecules into its smaller consituents and in doing so use up water.

Q. 6. *Name two enzymes of digestive system.*

Ans. *(i) Salivary amylase*—hydrolyses starch into disaccharides.

(ii) Trypsin—hydrolyses proteins into peptones and proteoses

Q. 7. *Which enzymes helps in the emulsification of fat ?*

Ans. Gastric lipase

Q. 8. *Which enzymes helps in curdling of milk ?*

Ans. Enzyme—Rennin

Q. 9. *What are rennet tablets ?*

Ans. These are tablets containing enzme rennin from calf stomach, available commercially and are used for coagulating milk protein for preparing cheese.

Q. 10. *What is the optimum temperature for most enzymes ?*

Ans. 37-38°

Q. 11. *Why enzymes are heat labile ?*

Ans. Because proteins are very sensitive to heat about 45° C, the proteins are denatured, so enzymes are destroyed or become nonfunctional. The reaction is nonreversible.

Q. 12. *What is Michaelis constant (Km) of an enzymes ?*

Ans. It is the substrate concentration at which the reaction attains half its maximum velocity.

Q. 13. *Name any two enzymes of respiratory system.*

Ans. *(i)* Phosphohexokinase

(ii) Dehydrogenases

Q. 14. *What is the name of that part of enzymes where catalytic work is carried out ?*

Ans. Active site.

Q. 15. *What does name of an enzyme indicate ?*

Ans. The name of enzyme consists of two parts—

(*i*) First part indicates the substrate on which enzymes acts.

(*ii*) Second part indicates the reaction catalysed by enzyme.

For example in enzymes glutamate-pyruvate transaminase

(*i*) glutamate and pyruvate are substrate

(*ii*) transminase shows transfer of amino acid *i.e.*, one amino acid is transferred from glumate to pyruvate.

□□

CORE EXPERIMENT 8

FACTORS AFFECTING PERMEABILITY OF PLASMA MEMBRANE IN PLANTS

STUDY OF LEACHING OF COLOUR FROM BEET ROOT/PLANT TISSUES CONTAINING ANTHOCYANIN PIGMENT DUE TO HEAT, FREEZING AND THAWING AND CHEMICALS (ALCOHOL, FORMALIN, BENZENE)

Aim : To study the factors affecting the permeability of cell membrane of plants. Study of leaching of colour from beet root discs due to heat, freezing and chemicals (alcohol, formalin and benzene).

Material Required

Equipments	Chemicals
1. Test-tubes	1. Alcohol
2. Cork borer (1 cm. diameter)	2. Formalin
3. Water bath	3. Benzene
4. Burner	4. Distilled water
5. Thermometer	**Material**
6. Ice cubes	Large, fresh beetroots.
7. Glass marking pencil	
8. Scale	
9. Sharp blade	
10. Measuring cylinder.	

Theory : Anthocyanin pigments are found in the vacuoles bounded by tonoplast. The selectively permeable tonoplast does not allow water soluble anthocyanin pigment to outflow from the vacuole. The plasma membrane is selectively permeable. It acts as a barrier between cell and extracellular fluid or outside. Transport of materials across cell membranes takes place either by diffusion, osmosis or by active transport.

Various factors like very high or low temperature (*i.e.*, heat or freezing), chemicals like benzene, alcohol, acids, alkalies etc., adversely influence the nature of living membranes and increase their permeability. The increased permeability causes leaching of substances from the cell. This can be observed by using beet root which contains pigment anthocyanin.

Procedure :

A. To study effect of Temperature on Cell Permeability

1. Select fresh large beet root and wash it under running water.

2. Cut cylinders of beet root with the help of the cork borer.

3. Cut each cylinder 1.0 cm. long, with the help of sharp blade. Both the edges should be clean and levelled.

4. Prepare 24 such beet root cylinders. All cylinders should be of same length and width.

5. Wash them in running water to remove the injured cells, otherwise the red pigment anthocyanin from such cells comes out and vitiate the results.

6. Take four clean tubes and mark them as A, B, C and D with the glass marking pencil.

7. Put 15 ml of distilled water in each tube, and put 3 beet root cylinders in each.

8. Cover the tubes with aluminium foil and place them at the following different temperatures :

(*a*) Test-tube at room temperature—A

(*b*) Test-tube at 50°C in water bath—B

(*c*) Test-tube at 70°C water bath—C

(*d*) Test-tube in freezing mixture of ice and salt in a beaker (0°C)—D.

9. Observe the leaching of pigments in these tubes after 15 minutes.

10. Compare the anthocyanin colouration in tubes B, C and D with that of A (Control).

11. Record your observations in table (A).

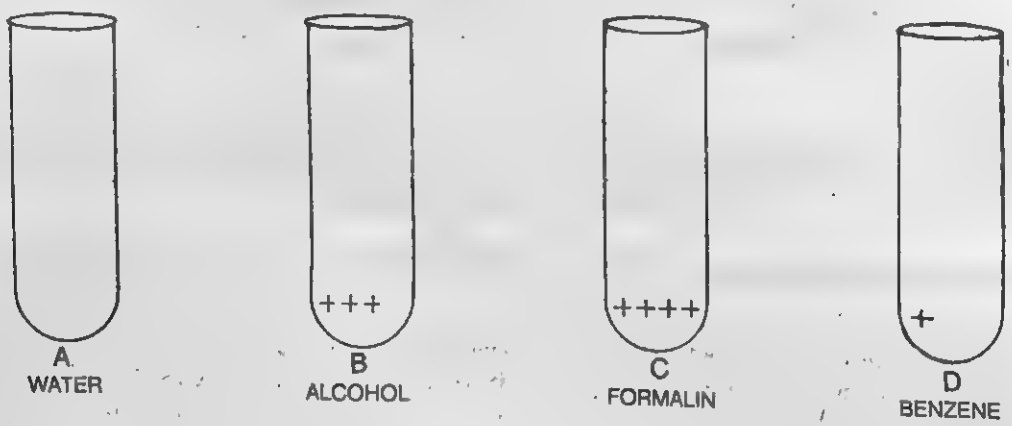


Fig. 9.1 : Effect of temperature on cell permeability.

Table A
Effect of Temperature

Each tube contains 15 ml of distilled water and 3 beet root cylinders of same size.

S. No.	Tube No.	Temperature	Observation	Degree of Leaching
1.	A	Room Temperature	No colour	No leaching
2.	B	50°C	Purple pink	Sufficient leaching
3.	C	70°C	Dark purple	Maximum leaching
4.	D	Ice 0°C		

B. To study the effects of chemicals on cell permeability

1. Take four test-tubes in the same way, label them as A, B, C and D.

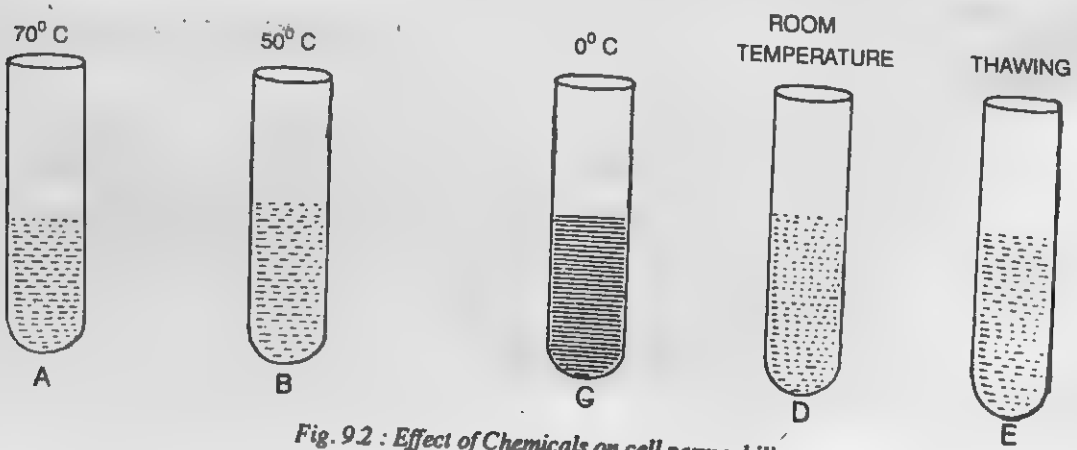


Fig. 9.2 : Effect of Chemicals on cell permeability.

2. Put 15 ml. of distilled water, alcohol, formalin and benzene each in respective tubes.

3. Put 3 equal sized washed beet root cylinders in each of the four tubes.

4. Keep these tubes covered at room temperature for 15 minutes.

Observations and Records

The experiment performed is a qualitative study. Therefore the intensity of colouration can be adjudged on the basis of control experiment. Loss of colour can be accounted on the basis of grades—such as recorded in Table B:

Table B

Effect of Chemicals

S. No.	Tube No.	Solvent	Observation	Degree of leaching
1.	A	Distilled water (control)	No colour	No leaching
2.	B	Alcohol	Purple pink	Sufficient leaching
3.	C	Formalin	Dark purple	Maximum leaching
4.	D	Benzene	Light pink	Slight leaching

5. Shake the tubes after 15 minutes and observe the pigments leached out. Compare the degree of leaching in the tubes B, C and D with that of A (control).

6. Record your observations in Table B.

Discussion

Beet roots contain *anthocyanin* pigment dissolved in the cell sap. The vacuoles of these cells retain the pigment due to living membrane tonoplast and others. When the discs are being prepared cell membranes of many of cells are damaged. Hence leaching of pigment takes place. This pigment can be washed out by placing the discs under tap water for 5-10 minutes. When a temperature or chemical treatment is given to the tissues, the permeability of the cell membrane is affected. High temperature and thawning damage the membrane. Similarly chemicals being organic solvents dissolve fat from the membrane and denature the proteins—thus damage is caused and permeability is increased. The anthocyanin pigment leaches out of vacuoles and mixes with the solvent. In the test tube containing benzene, you may be able to see droplets of pigment floating. Benzene can dissolve fats only and not protein molecules. Membrane shrinks with slight leaching. Anthocyanin is not soluble in benzene.

Inference

High temperature kills the cell membrane thereby making it fully permeable ; hence at high temperature (100°C) maximum leaching of betacyanin pigment is seen.

Similarly the organic solvents like formalin and alcohol damage the cell membrane by dissolving fat and denaturing proteins. Hence, the cell membrane becomes more permeable and hence more leaching of pigment is seen.

Precautions

1. Cylinders should be of equal length and width.

2. The edges of cylinders must be levelled by a sharp blade.

3. The injured cells on the sides of cylinders must be washed under running water.

4. Volume of water or other chemicals must be the same in all the tubes.

5. The number of beet root cylinders should also be the same in all tubes.

ORAL QUESTIONS

Q. 1. *What is leaching ?*

Ans. Leaching is escaping or coming out of pigment from cells whose cell membranes are damaged or have been highly permeable.

Q. 2. *Why pigment does not come out of the intact cells ?*

Ans. Cell membrane at room temperature is impermeable to large pigment molecules.

Q. 3. *What pigment leaches out of beet root ?*

Ans. Anthocyanin or Betacyanin.

Q. 4. *What factors increase permeability of cell membrane ?*

Ans. Increase in temperature, alkali, formalin or alcohol etc., or even thawing release pigment from the cell cytoplasm.

Q. 5. *Why the cut surfaces of beet root cylinders be smooth ?*

Ans. Smooth and uniform surface of beet root discs provides a constant or uniform surface area and volume.

Q. 6. *What is the difference between diffusion and osmosis ?*

Ans. In *diffusion* a substance (solute) migrates from the region of its higher concentration to the region of its lower concentration.

In *osmosis* the solvent (water) passes through a semi-permeable or permeable membrane from a region of high osmotic concentration to a region of low osmotic concentration.

□□

CORE EXPERIMENT 9-A

DEMONSTRATION OF EFFECT OF HYPOTONIC, ISOTONIC AND HYPERTONIC SOLUTIONS ON RBC CAUSING HAEMOLYSIS OR CRENATION

Aim : Effect of isotonic, hypertonic and hypotonic solutions on RBCs and plant cells to show haemolysis, crenation and plasmolysis.

Material Required :

Chemicals

Saline solution (NaCl solution) of following concentration 0.5%, 0.9%, 2%, 5% and distilled water.

Equipment :

Test tube stand, test tubes, coverslips, slides microscope, needle or pricker.

Theory :

Plasma membrane is permeable to water but semi-permeable for other substances. The passage of substances through plasma membrane in or out of the cell depends on its requirement.

All cells are surrounded with a fluid (ECF). Its osmolar concentration is equal to the osmolar concentration of cell cytoplasm. Such a fluid is called *isotonic*. If osmolar concentration of outer fluid is less than the osmolar concentration of cell *cytoplasm*, it is called *hypotonic* and if more it is *hypertonic*.

1. In **isotonic solution** cells do not undergo any change. For human RBCs 0.9% NaCl is isotonic to blood. In isotonic solution there is no net movement of water molecules across the cell membrane.

2. In **hypotonic solution** the water from the surrounding medium diffuses into the cell (endosmosis). The cell swells up and may even rupture due to excessive accumulation of water inside.

3. In **hypertonic solution** water from cell cytoplasm diffuses out into the medium, causing cell to shrink (exosmosis)

Red blood cells are rapidly affected by changes in the osmolar concentration and either increase or reduce in size by crenation in hypotonic or hypertonic fluids respectively. These are used to demonstrate phenomenon of osmosis.

(*a*) In *hypotonic solutions* the red blood cells haemolyse and release their haemoglobin. Such haemolysis is called osmotic *haemolysis*. The red blood cells can also be haemolysed by agents which dissolve the plasma membrane. This is called *non-osmotic haemolysis*.

(*b*) In *hypertonic solutions* the red blood corpuscles shrink due to *exosmosis* and their surface appears *crenated*.

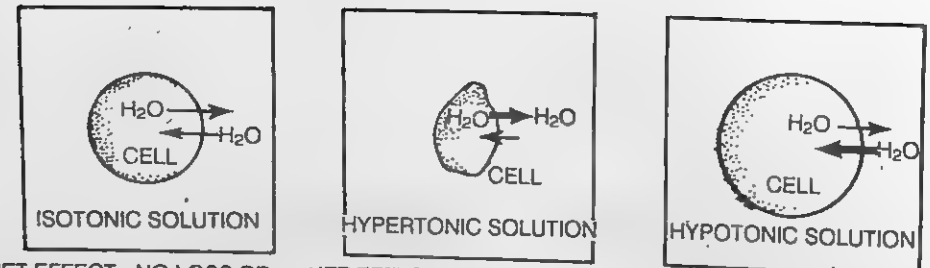
Procedure :

1. Mark the test tubes with No. A, B, C, D, E and arrange them in a test tube stand.

2. Take one c.c. of distilled water in test tube number A and NaCl solution of the above mentioned concentrations in test tubes B, C, D and E respectively.

3. Take 5 slides and mark them with serial numbers A, B, C, D, E.

4. Place two drops of distilled water on slide number-A and add a drop of blood and cover with the coverslip and observe under the microscope.



NET EFFECT : NO LOSS OR GAIN OF WATER BY THE CELL

NET EFFECT : WATER PASSES OUT OF THE CELL

NET EFFECT : WATER ENTERS THE CELL

Fig. 9.1 : Figures showing the effect of Isotonic solution. Hypertonic solution and Hypotonic solution.

Note down the changes seen in the shape of R. B. Cs.

5. Now place two drops of 0.5% NaCl solution (hypotonic) on the slide B and add one drop of blood. Cover it with the coverslip and observe under the microscope. Note down the changes seen in R.B.Cs. and at what rate.

6. Place two drops of 0.9% NaCl solution (isotonic) on slide No. C and add one drop of blood to it. Cover it with the coverslip and observe under the microscope. Note down what you see under the microscope.

7. Place two drops of 2% NaCl solution on the slide No. D. and add a drop of blood to it. Cover it with the coverslip. After two minutes observe under the microscope and note the changes seen in the shape of R.B.Cs.

8. Place two drops of 5% NaCl solution on slide No. E and add a drop of blood to it. Cover it with the coverslip and study under the microscope.

Observations :

Slide No. A—R.B.Cs enlarge by imbibing water and finally rupture liberating haemoglobin and cytoplasm in the watery medium—Haemolysis.

Slide No. B— Results are the same as in case of slide No. 1 but the changes are slow.

Slide No. C—R.B.Cs retain their normal appearance and size.

Slide No. D—R.B.Cs gradually shrink and their outer surface presents *crenations*.

Slide No. E—R.B.Cs show *crenations* but this process occurs more speedily.

Discussion—For man 0.9% NaCl is isotonic to the tissue fluid. That is why R.B.C.s in slide No. C with .9% NaCl solution remain unchanged. When conc. of NaCl is less than .9% it is hypotonic. Therefore in slides A and B water starts diffusing into R.B.Cs. Due to endosmosis water starts accumulating in R.B.Cs. which first swell up and

Observations: Effect of isotonic, hypotonic and hypertonic NaCl solution on R.B.Cs.

S. No.	Slide No.	% of NaCl soln.	Observations	Inference
1.	A	Water	R.B.Cs. rupture rapidly	Haemolysis (Endosmosis)
2.	B	.5%	R.B.Cs. rupture but slowly	Haemolysis occurs slowly (Endosmosis)
3.	C	.9%	R.B.Cs. retain normal size of their own.	No osmosis and no change in the size of R.B.Cs.
4.	D	2%	R.B.Cs. gradually shrink, outer surface shows crenations	Crenation indicates occurence of *exosmosis*
5.	E	5%	R.B.Cs. show crenation very rapidly	Crenation (*Exosmosis*)

finally rupture because of increased pressure inside. It is haemolysis.

In slides Nos. 4 and 5, the NaCl solution is hypertonic. Therefore, water from R.B.Cs. diffuses out into the NaCl solution. As a result, the R.B.Cs. shrink and crenation appears on the surface.

Precautions :

1. Needle and finger should be sterilized.
2. Coverslip, slide and test tube should be clean.
3. Slide should not be allowed to dry.
4. Solution and blood drop should be mixed thoroughly.

CORE EXPERIMENT 9-B

Aim : Demonstration of effect of hypertonic solution on plant cells causing plasmolysis.

Material Required :

Equipments	Solutions
Watch glasses-3	Sugar solution of
Slides	following concentrations
Coverslips	0.5 M, 0.25 M and .1 0M
Microscope	
Brush	**Material**
	Rhoea leaves or Hydrilla leaves

Theory :

Exosmosis and Plasmolysis

If a plant tissue or cell which is in turgid state, is placed in a hypertonic solution exosmosis takes place, *i.e.*, water from within the cell sap diffuses out through the membrane into the outer solution. As water leaves the cell, the cell wall is no longer under tension. Further loss of water from the cell contents causes contraction of the protoplasm which moves away from the cell wall. If the hypertonic solution is very strong, the protoplasm will go on contracting and will eventually assume a spherical form. This phenomenon is called **plasmolysis**. The space between cell wall and the contracted protoplasm gets filled with the external solution. The stage of plasmolysis at which the first sign of shrinkage of the cell contents from the cell wall becomes detectable is referred to as the stage of **incipient plasmolysis**. The various stages of plasmolysis can be easily seen under the microscope (Fig. 9.4).

If a plasmolyzed cell is placed in pure water or in a hypotonic solution endosmosis takes place and the protoplasm as well as the cell as a whole attain their original shape and size respectively. The phenomenon is called **deplasmolysis**.

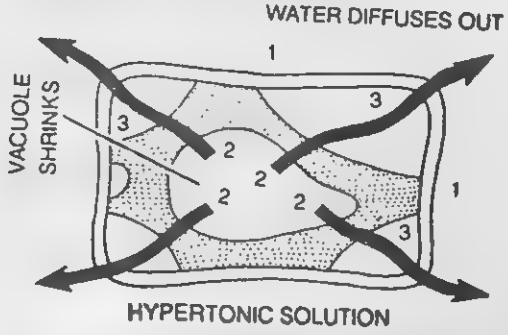


Fig. 9.2 : Diagram showing exosmosis when a cell is kept in hypertonic solution.

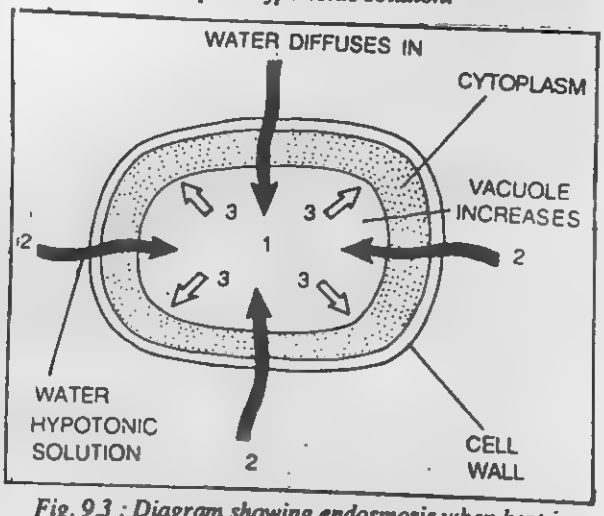


Fig. 9.3 : Diagram showing endosmosis when kept in hypotonic solution.

Procedure :

Put epidermal peels of *Rhoeo discolour* in different watch glasses containing solutions of different concentration of sugar *i.e.*, 0.5 M, 0.25 M, 0.10 M sucrose for few minutes. Now prepare the temporary mount of the peeling of different watch glasses and observe them under the microscope.

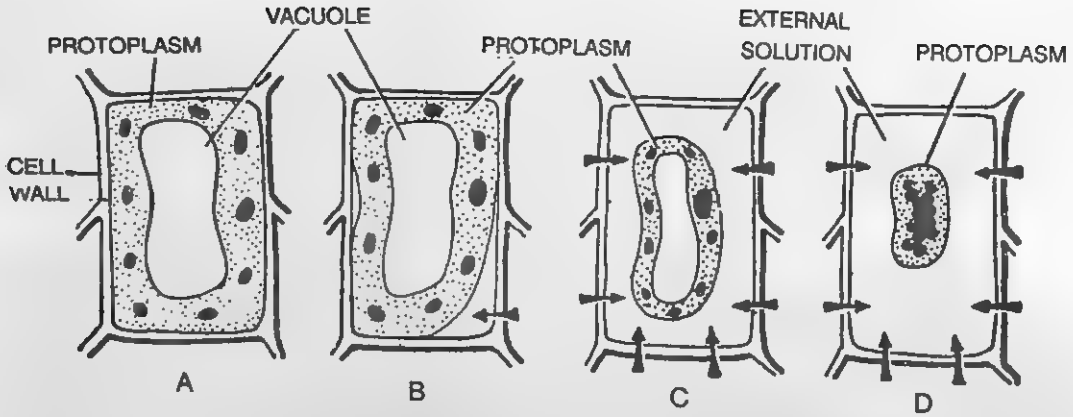


Fig. 9.4 : A. Turgid cell; B. Incipient plasmolysis ; C. Plasmolysis ; D. Complete plasmolysis.

Observation :

(*i*) Solution of 0.5 M concentration peeling shows complete plasmolysis (Fig. 9.5C).

(*ii*) Solution of 0.25 M concentration peeling shows incipient plasmolysis (Fig 9.5B).

(*iii*) Solution of 0.10 M concentration peeling shows full turgid condition (Fig. 9.5A).

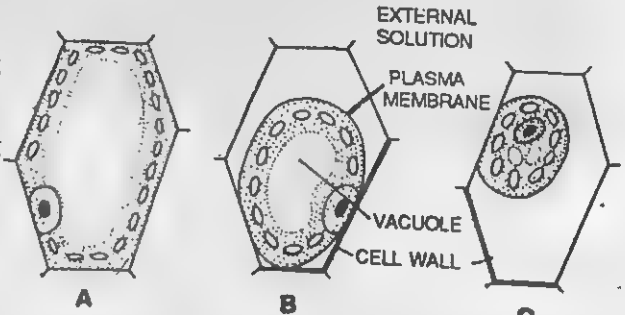


Fig. 9.5 : A—Turgid condition ; B—Incipient plasmolysis; C—Complete plasmolysis

Table

S. No.	Molarity of sugar solution	Osmotic potential	Degree plasmolysis
1.	0.50 M	— 13.0	Complete plasmolysis
2.	0.25 M	— 6.7	Incipient plasmolysis
3.	0.10 M	— 2.6	Turgid condition

Explanation :

(*i*) Sugar solution of 0.5M concentration brings about plasmolysis in the cells which indicates that exosmosis is taking place *i.e.*, concentration of outer sugar solution acts as hypertonic one.

(*ii*) Sugar solution of 0.25 M concentration brings about incipient plasmolysis in the cells which indicates that the osmotic concentration of outer sugar solution is just equal to the cell sap. Here the sugar solution acts as Isotonic one.

(*iii*) Sugar solution of 0.10 M concentration brings about turgidity in cells. This indicates that endosmosis is taking place *i.e.*, concentration of outer sugar solution is lesser than that of cell sap. It means sugar solution is hypotonic.

Result :

1. Hypertonic solution causes exosmosis resulting in plasmolysis.
2. Hypotonic solution brings about endosmosis causing turgid condition.

Precautions :

1. Do not allow leaves or peel-cells to dry.
2. Use separate droppers for each sucrose solution.

ORAL QUESTIONS

Q. 1. *What is osmosis ?*

Ans. When two solutions of different concentrations are separated by a semi-permeable membrane the diffusion of water or the solvent from its higher concentration to its lower concentration (*i.e.*, from less concentrated solution towards more concentrated solution) is called osmosis.

Q. 2. *What is osmotic pressure ?*

Ans. Osmotic pressure is the hydrostatic pressure developed during endosmosis by the incoming water which diffuses inside the cell.

Q. 3. *What is osmotic potential ?*

Ans. Osmotic potential is defined as the decrease in the chemical potential of solvent in a solution which occurs due to presence of ionic or non-ionic solute particles. It is denoted by π which can be expressed in energy terms.

Osmotic potential is characterized by a negative value since π for pure water is taken as zero by convention and gets lowered with the increase in the number of solute molecules.

Q. 4. *What is the difference between exosmosis and endosmosis ?*

Ans. In exosmosis water or solvent diffuses out of the living cell. It occurs when cells are placed in a hypertonic solution.

In endosmosis water or solvent diffuses from outer solution into the living cell when cells are placed in hypotonic solution.

Q. 5. *What is a molar solution ?*

Ans. A Molar solution (*m*) contains 1g molecular weight in 1 litre of water.

Q. 6. *Differentiate between molal and molar solution ?*

Ans. A molal solution contains 1g molecular weight of a substance and 1000 ml of water. While molar solution contains 1g molecular weight of a substance in one litre water.

Q. 7. *What is plasmolysis ?*

Ans. Plasmolysis is the shrinkage of cytoplasm of the cell due to exosmosis when it is placed in a hypertonic solution.

Q. 8. *What is incipient plasmolysis ?*

Ans. It is the stage when plasmolysis just begins and the cell's membrane just start receding from the cell wall.

Q. 9. *What is deplasmolysis ?*

Ans. When a plasmolysed cell is kept in a hypotonic solution or in water, the plasmolysed cell becomes turgid again by absorbing water (endosmosis).

Q. 10. *What do you mean by permeability ?*

Ans. Permeability is the ability of plasma membrane of a living cell to allow passage of substances into and out of it.

Q. 11. *Why plasma membrane is described as semipermeable ?*

Ans. Plasma membrane is semi-permeable because it is permeable to some substances and impermeable to others. It may also be called differentially or selectively permeable.

Q. 12. *What factors influence permeability of plasma membrane ?*

Ans. Permeability of plasma membrane is affected by the size of particles, the concentration of the substance inside and outside, temperature and other conditions inside and outside the cell.

Q. 13. *Name four substances for which plasma membrane is highly permeable ?*

Ans. Plasma membrane is highly permeable for water, CO_2, O_2, alconol, monosaccharides etc.

Q. 14. *What is osmotic haemolysis ?*

Ans. Osmotic haemolysis is the rupture of RBCs so as to release its content due to endosmosis of water. Osmotic haemolysis occurs when RBCs are kept in distilled water.

Q. 15. *What is the difference in plasmolysis and crenation ?*

Ans. When a plant cell is kept in a hypertonic solution, the plasma membrane shrinks off the cell wall leaving space between call wall and cell cytoplasm which looses water due to exosmosis. This is called plasmolysis.

In animal cell the cell wall is wanting. When animal cells (Say RBCs) are placed in hypertonic solution. The cytoplasm starts shrinking due to exosmosis and cell surface starts showing folds or crenations.

Q. 16. *Define osmotic pressure.*

Ans. Osmotic pressure is the maximum amount of pressure that is a developed in solution separated from pure water by a semi-permeable membrane.

□□

CORE EXPERIMENT 10

PREPARATION OF SLIDES OF FROG BUCCAL EPITHELIUM/GUT CILIATES OF FROG PARAMECIUM TO STUDY CILIARY BEAT

Aim : To prepare slides and study ciliary beat in

(a) Buccal epithelium of frog
(b) Gut ciliates of frog
(c) Paramecium

Material Required

Equipment	Animals
Microscope	Freshly chloroformed frog
Slide	Paramecium culture
Coverslip	
Dropper	
Needle	
Cotton wool	**Reagent**
Tooth-pick or scalpel	Amphibian saline .6% NaCl

A STUDY OF CILIARY BEAT IN BUCCAL EPITHELIUM OF FROG

Theory

Cilia are minute, fine, hair-like structures present on the surface of microscopic animals and few cells of multicellular organisms. Collective beating of cilia creates a current in the surround fluid. In unicellular organism cilia help in locomotion by creating a water current that pushes body foward. In multicellular organisms cilia help in the flow of substances.

Procedure

1. Keep a dry and clean slide and a clean coverslip.
2. Put one or two drops of amphibian saline (.6% NaCl on the slide).
3. Open the buccal cavity of a freshly chloroformed frog by pulling apart the upper and lower jaws.
4. With the help of toothpick or scalpel, gently scrape out slimy substance from the roof of buccopharyngeal cavity.
5. With the help of needle or fine brush transfer this scraping on to the saline drop on the slide.
6. Spread it uniformly and put a coverslip.
7. Focus under low power of microscope and then study under high magnification.

Observations

Observe vibrations. These are due to the beating of cilia attached to the cells of buccal epithelium.

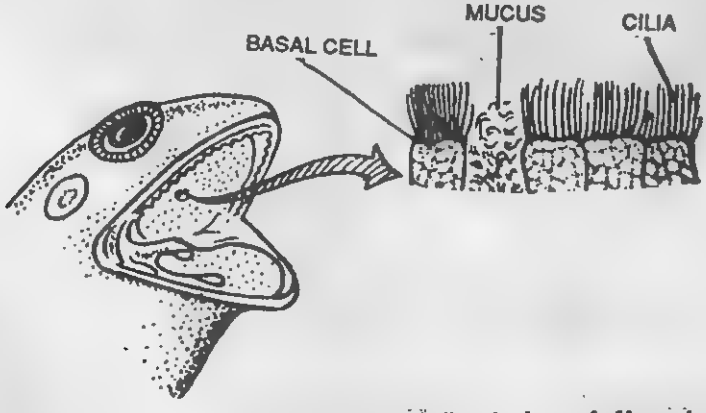


Fig. 10.1 : Diagram to show location of ciliated epithelium in the roof of buccal cavity of frog

Precautions

1. Frog should be freshly killed.

2. Blot off any extra fluid before observing under the microscope.

B. STUDY OF CILIARY BEAT IN RECTAL CILIATES OF FROG

Procedure

1. Cut open a freshly chloroformed frog. Remove its rectum.

2. Slit the rectum longitudinally and empty its content in a small petridish or a test tube containing amphibian saline (.6% NaCl). Mix the rectal contents well .

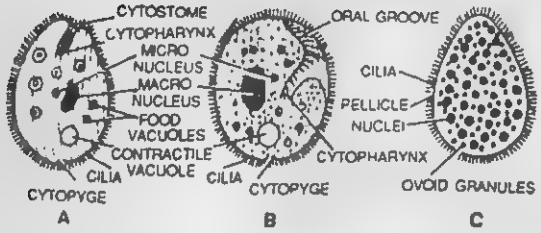
3. Keep the material to settle down.

4. With the help of dropper collect fluid from the surface and put a drop of this solution on a clean slide and observe under the microscope under low power first, then under high power.

Observations

Observe swift movement of ciliates - *Opalina, Nyctotherus* and *Balantidium* produced by beating of their cilia.

Insert few threads of cotton wool under the coverslip to arrest the movement of ciliates and observe under the microscope the beating of cilia.



A — Balantidium B — Nyctotherus
C — Opalina

Fig. 10.2 : Rectal ciliates of frog

C. STUDY OF CILIARY BEAT IN PARAMECIUM

COLLECTION OF PARAMECIA

1. Collect in a beaker or glass-jar water along with living matter from some nearby pond, pool or ditch where decaying matter is in abundance or procure paramecium culture.

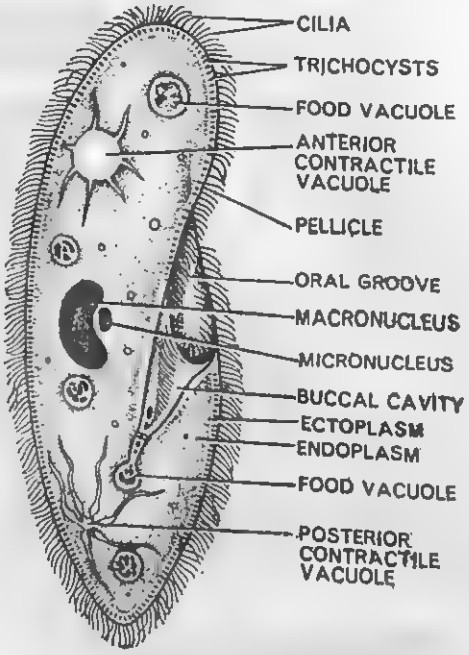


Fig. 10.3 : Paramecium

Procedure

Put one or two drops of this water on a clean slide. Cover it with a coverslip and observe under microscope. First under low power and then change to high power. Cut out a little light.

Observation

If paramecia are there, they appear as shining specks darting in and out of the microscopic field and moving about in a zigzag manner. To slow down this movement for observation quickly invert the slide over a bottle of glacial acetic acid and expose the drop to its fumes for a few seconds (Fig. 10.5). Then put cover slip and observe. If even after this, the rapid movements do not stop, then introduce a drop or two of the acetic acid from the side of coverslip.

Note : If the drop of water is tiny enough, it will not fall off.

Ciliary beat can be observed first as a flickering movement of the fluid. Close inspection of this area under high power will show thousands of cilia that beat like miniature oars. In case of proper exposure to the acetic acid fumes, the cilia slow down their movements and a much clearer idea is obtained of the manner in which cilia beat. Cutting out little light often helps. You can also introduce a drop of methylene blue or dilute congo red stain.

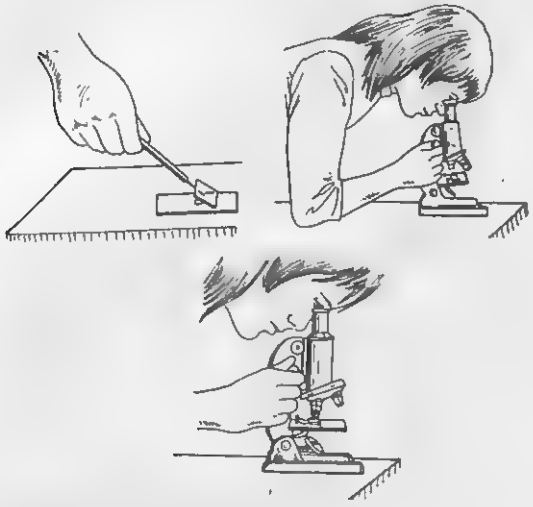


Fig. 10.4 Mounting and study under the microscope

This will show the nuclei stained and some other cytoplasmic inclusions can be made out.

Alternative process : In order to trap these micro-organisms, a very finely teased out meshwork of cotton wool kept in the water drop will help. The Paramecia get restricted in their movements because of the threads.

Important Note

It is difficult to see individual cilia. What can be seen clearly is segments of cilia in wave-like fashion. Do not expect them to stick out from the membrane, as given in text books. Patience is another important requirement. You must observe the *animal*, concentrating with honesty, and allow your eyes to get adjusted to the particular focussing. Considering the limitations of our lab. microscopes, do not expect to see all the orgaenelles very clearly. If you have got a very good slide, you will see besides the beating segments of cilia, mega and micro nuclei, the oral groove, contractile vacuoles, cytoplasmic granules. This kind of contraction is possible at 400x (or more) (Fig. 10.3).

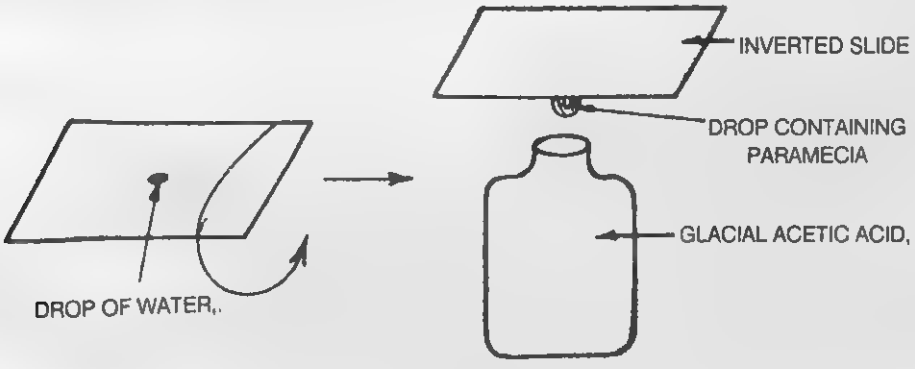


Fig. 10.5. Diagram to show fixing of paramecia on a bottle of glacial acetic acid.

ORAL QUESTIONS

Q. 1. *What is ciliary beat ?*

Ans. It is beating of cilia or movement of cilia.

Q. 2. *What is the use of ciliary beat ?*

Ans. (*i*) Beating of cilia in protozoans (ciliates) helps in locomotion.

(*ii*) Beating of cilia produces a flow of water current.

(*iii*) Cilia of oral groove in Paramecium help in feeding.

(*iv*) Cilia in the roof of buccal cavity help in spreading mucus secreted by goblet cells.

Q. 3. ***What is synchronous rhythm ?***

Ans. The simultaneous movement of cilia of a row exhibit synchronous rhythm. Cilia arranged in transverse rows on the body of Paramecium exhibit, synchronous rhythm.

Q. 4. ***What is metachronous movement of cilia ?***

Ans. In metachronous rhythm or movement, beating of one cilium is followed by the next one in succession.

Q. 5. ***What is a tissue ?***

Ans. A group of cells carrying out same function.

Q. 6. ***What are cilia ?***

Ans. Cilia are protoplasmic projections.

□□

CORE EXPERIMENT 11–A

COLLECTION, IDENTIFICATION AND PRESERVATION OF PLANTS AND ANIMALS

Aim : Collection, Identification and Preservation of plants and animals of the locality belonging to different groups and habitats.

Theory

Collection, identification and preservation is an important and interesting aspect of biological studies. It involves :

1. Carefully planned field trips.

2. Awareness and correct information of local flora and fauna.

3. Information of material that is easily available in a particular area.

4. Awareness of seasonal variation and their influence on plant and animal life.

5. Possession of required instruments, equipments and reagents.

Methods of collection and preservation of plants and animals are entirely different. Therefore these will be discussed separately.

A. COLLECTION OF PLANTS

Methods of Collecting Plants

Plants belong to different groups and to different habitat. These are of different sizes also. Small plants can be collected as a whole, while the larger ones cannot. These can be preserved by drying or in solution in glass jars. Aquatic plants cannot be dried.

1. *Collection and Preservation of aquatic plants.*

Aquatic plants can be collected along with water in beaker or through a strainer. These are preserved :

(*i*) in 4.5% formalin, or

(*ii*) in a preservative prepared from potassium

chrome alum	–10 gm
40% Formalin	–5 ml
Water	–500 ml

2. *Collection and Preservation of Mushrooms or other fleshy fungi :*

These may be collected carefully from the moist areas and preserved in the following solution.

40% commercial formalin	–6 ml
50% alchohol	–100 ml

Note : Mushrooms are very delicate and should be handled carefully. These may be poisonous even. Pick them up with forceps.

3. *Collection and Preservation of Mosses and Liverworts :*

These are scrapped off from the substratum with a scalpel or knife and preserved in the following solution.

40% Formalin	–5 ml
Water	–72 ml
Glycerine	–20 ml
Glacial acetic acid	–3 ml

4. *Collection of fleshy plants :*

Fleshly xerophytes or hydrophytes cannot be dried without losing their appearance. These are preserved in formalin or FAA in the specimen jars.

5. *Collection and Preservation of Gymnosperms and Angiosperms* (preparation of Herbarium)

WHAT IS HERBARIUM ?

A **herbarium** is the collection of dried and preserved plants arranged in a sequence according to some standard system of plant classification. **(Benthem Hooker's method or Engler and Prantle method or Hutchinson method).** The plants preserved in herbarium are used to check the description of plants newly collected from the preserved specimens.

Equipment for Plant Collection

Following equipments are required during plant collection.

(*i*) *Vasculum :* A metallic box carrying collected plants from the field to laboratory. It is kept moist by lining with a moistened filter paper or a moist muslin cloth to keep the collected plant fresh for a longer duration.

(*ii*) *Plant-press :* It consists of two wooden flat boards or aluminium sheets. In between the boards are kept blotting paper sheets or old news papers. The collected plant specimens are spread on these sheets and are tied by a pair of leather straps.

(*iii*) *Shears or sceater or scissors :* For cutting hard and woody specimens.

(*iv*) *A pair of forceps.*

(*v*) *A pocket lens or Hand lens.*

(*vi*) *Polythene bags :* To collect aquatic specimens, *polythene bags or glass bottles* are used. Polythene bags are preferred since they are light in weight and can be transported easily.

(*vii*) *Old newspapers or blotting sheets.*

Some plants like fleshy xerophytes or hydrophytes cannot be dried easily without losing their appearance. Therefore, they are preserved in liquids in the specimen jars.

Method of Plant Collection

(*i*) Usually the trips are organised in the morning hours. This helps the students to utilise the rest of the day for the arrangement of the collected plants.

(*ii*) Those plants are selected which have flowers, fruits and seeds. The size of the plant should be between 20-25 cm. As far as possible the entire plant with root, stem, leaves, flowers and fruits be collected. If the fruits, seeds are not available intact they can be picked up separately, which can be dried and mounted on the herbarium sheets separately.

Four methods of collecting specimens are recommended—

(*i*) The most common method is to collect and press the specimen in the field itself. The plant is spread in its natural shape on the newspaper. If possible note down the name of the plant also. Few blotting paper sheets can also be used between the newspaper sheets for quick evaporation and absorption of moisture. These sheets are then pressed in the press.

(*ii*) If adequate facilities are not possible in field, the plants collected are brought to the laboratory in a vasculum. In the laboratory the plants are arranged. Identification of fresh plants is recommended for herbarium.

(*iii*) During a long excursion the specimens are collected in a rugsack and then arranged as soon as possible after returning from the camp.

(*iv*) In case a press is not available the newspaper sheets alongwith the specimens can be placed under a steel box for uniform weight, since the plants retain their shape and colour if dried under uniform weight.

The newspaper sheets absorb moisture from plants and the sheets are moistened in turn. Therefore these sheets are changed daily for 3-4 days. By then plants lose maximum water from them. Afterwards the sheets can be changed every third day.

Mounting : The completely dried plants are mounted on *herbarium sheets.* These sheets are

made out of chart paper, which does not lose its colour with time. The size of herbarium sheet is 28 × 40 cm. One plant is mounted on one sheet in the centre. The material used for mounting is usually glue, needle and thread or cellotape depending upon the nature of the plant if it is brittle or soft. Fruits and seeds can be put into small packets and are attached to the herbarium sheet.

Labelling : The plants are identified upto family or genus or species and the information is recorded at the right-hand lower corner of the sheet as following—

Name of the school—

1. Name of the plant. (*a*) Botanical name, (*b*) common name—
2. Family—
3. Locality—
4. Date of collection—
5. Students Name—
6. Identified by—
7. Economic importance or any other important information—

Arrangement of Plants in Herbarium : The identified plants are then arranged in a cover for presentation. If the plant specimens are of big size such as fruits with interesting features, they can be mounted in card board boxes alongwith identification. The herbarium sheets can be stored and preserved in herbarium cabinet by arranging them familywise. Few naphthalene balls are also kept to avoid insects.

These specimens can now be arranged in the museum according to their classification.

Key for Collection of Few Common Plants

S. No.	*Name of Plant*	*Habitat*
	A. Algae	
1.	*Chlamydomonas*	Stagnant pools, ditches ; Forms a green surface layer on water (during rainy season).
2.	*Spirogyra*	In ponds, pools, streams ; forms a free floating mat on water surface ; Dark green and slimy.
3.	*Ulothrix*	In ponds, pools, streams ; forms a free floating mat on water surface ; Dark green and slimy.
	B. Fungi	
4.	*Rhizopus (bread mould)*	Grows on bread, when it is kept for 2 or more days in damp and dark atmosphere.
5.	*Agaricus (Mushroom)*	Grows on humus soil, dung, rotten logs ; during rainy season.
6.	*Puff balls*	Common in damp places, on human night-soil.
	C. Bryophytes	
7.	*Lichens*	Common on hills ; grow on tree trunks and rocks.
8.	*Liverworts*	On hills (Himalayas) ; grow on moist damp places and wet open woodlands.
9.	*Moss*	Common on hills as well as in plains ; grow on moist wall and tree-trunks.
	D. Pteridophytes	
10.	*Ferns*	Very common in Himalayas ; are cultivated in plains for foliage as ornamental plants.
	E. Gymnosperms	
11.	*Cycas*	On hills, grow as tall trees.
12.	*Pinus*	On hills, grow as tall trees.

CORE EXPERIMENT 11–B

Aim : Collection and preservation of animals of the locality from different habitats.

Some commonly available animals almost everywhere are :

(1) Protozoans like *Amoeba*, *Paramoecium*, *Euglena* etc.

(2) Fresh water sponges or marine sponges in case one is near the sea.

(3) Earthworms and leeches.

(4) Parasitic worms like Tapeworms, Round worms, from animal's alimentary canals, lungs, liver etc., (from butcher house).

(5) Arthropod, insects like Cockroach, Beetles, Moths, Butterflies, Mosquito and House fly. Others like spiders, Scorpions, Millipedes and centipedes.

(6) Snails and slugs.

(7) Frogs and toads.

(8) Small pond fishes.

(9) Local birds.

(10) Lizards, snakes.

(11) Small mammals like Rats, Squirrels, Rabbits, etc.

It will not be possible to discuss the collection and preservation methods for all. Collection of some that can easily be handled is given below :

How to collect organisms ?

Slow-moving animals like snails can be collected by hand. Most animals are obtained by capturing them. One of the most useful devices for doing this is a *net* or a *trap*.

1. Nets

A net should be large enough to contain the animal without damaging it, and the mesh should be fine enough to prevent the animal getting out.

Nets are useful for catching both aquatic

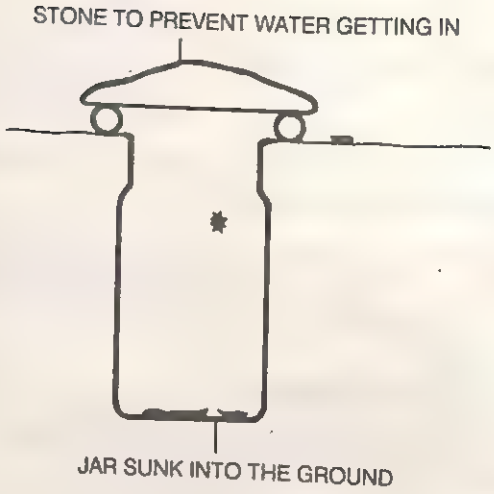


Fig. 11.4 : A pitfall trap for collecting insects that live on the ground.

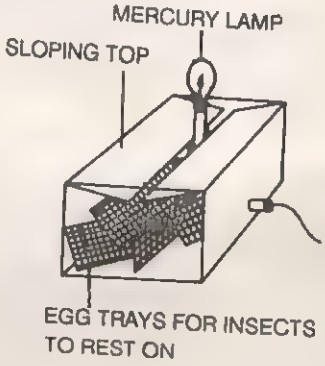


Fig. 11.5 : A moth trap.

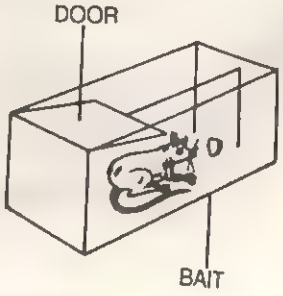


Figure 11.6 : A trap for catching small mammals.

animals and land animals. To catch very small aquatic animals, such as insect larvae and protozoans, a fine net with a bottle at the end is used. For larger animals, a dragnet may be needed. This consists of a bag attached to a rectangular frame. It is thrown into water and then pulled towards the shore. A similar kind of net can also be dragged over land and is useful for collecting insects and other small animals from long grass or marshy land.

2. Traps

Some animals are shy and timid, or only come out at night. These can only be caught by using some kind of trap. To catch insects which live on the ground a pitfall trap can be used. It consists of a jam jar which is sunk into the ground and covered with a stone. Insects can be enticed into the trap by putting bait inside : decaying meat will attract scavengers, and honey or jam will attract insects that normally visit flowers and feed on nectar.

Have you noticed that on a summer night swarms of flying insects may gather round a light ? This fact is made use of in collecting moths. A moth trap is shown in Fig. 11.5. It's best to use a mercury-vapour lamp because this gives out a lot of ultra-violet light to which insects are particularly attracted.

For small mammals such as mice and moles a mammal trap is used. This is a metal box, approximately 15 cm × 8 cm × 8 cm. At one end there is a door and at the other end there is a place for the bait, such as a piece of cheese. If a mouse enters the box and nibbles the bait, a mechanism is released which closes the door and traps the animal. It's rather like a mousetrap, but instead of killing the animal, it captures it without harming it.

Identification

Classification upto Phyla, Class and Order can be done without difficulty. Further classification upto families, genera and species often needs consultation of Taxonomy books and more experience. At school level details of complete classification is not usually required. Any student can classify at least upto order level. However, help can always be taken and the animal completely classified, when one is interested to do so.

Sketches and Notes

Drawing a rough diagram, purely based on what you actually observe is absolutely essential. Please make earnest effort, not to draw a book diagram you are familiar with. You may make grave mistakes in actual identification. You have to draw what you actually see and NOT what you expect to see. Similarly write notes on whatever structure and function you observe. Do not bother, even if your notes are haphazard. Once you *satisfy* yourself that, you have drawn and noted down every possible thing, only then you can refer to a laboratory manual or text book for comparison, corrections and other details ; finally arrange your notes and fair your diagram.

General Requirements for a Collection Trip

You must always carry with you at least the following :

(1) Note book and pencil.

(2) Plastic bags or bottles.

(3) Droppers, forceps, needles, scissors.

(4) Chemical bottles.

(5) Insect nets.

Note : Specific requirements have been mentioned as and when required, specially regarding the chemicals.

PROTOZOA

Habitat : Ditches and depressions filled with water and containing plant remains (algae etc.) surface scum of ponds, open drains are ideal sources.

Collection : Bottles with stoppers or jars with lids are needed for the trip. Container should not be filled more than one half, and the stoppers and lids should be removed as soon as possible after returning to the laboratory for aeration. Cultures can be obtained from this and according to requirements, can be preserved. In general living cultures of protozoa are more instructive.

Culturing : Pour out the contents in wide pans, add grass leaves, etc., and enough water to more than cover the material. Allow this to stand in a warm place but not in direct sunlight. Examine a

drop at intervals of 24 to 48 hrs. Marked changes in population will be noticed, which will be very dense in 10-15 days and then a steady decline to very small population. Also, definite types will appear and disappear in a sequence during this time. Therefore, if subcultures are to be made, they should be made within this time.

Preservation : This becomes necessary when a good culture is obtained, and structural details can be easily studied. Not all forms can be preserved equally well in all preservatives, but a 10 percent formalin is a good universal preservative. Another preservative (F.A.A.) consists of :

50% alcohol	90 parts
49% formalin	5 parts
Glacial Accetic Acid	5 parts

This acts as a killing and fixing agent and can preserve material indefinitely. The addition of glycerine to above (5 parts of above) will keep the animals from becoming brittle.

Procedure : Fill up a medicine dropper with culture. Observe under a hand lens to make sure that numerous animals are present. They appear as white specks darting back and forth.

Run the culture into a dish or bottle containing 2-5 times as much preservative as you have in the culture medium (or the medium may dilute the preservative to a point which may not be effective). Always run the culture into the preservative and not vice versa. Lids or corks/stoppers of containers should be dipped in paraffin wax to prevent evaporation.

In the above culture mixture, ciliates are very commonly found. These include Paramecium, *Nyctotherus*, *Balantidium* etc. *Amoeba* are not so easily found in mixed cultures, when found, they will be on the bottom of the container or on leaf surfaces. Among flagellates, *Euglena* is common. Pure cultures can be made from this mixture, by using specific culture media and procedures.

Identification : All single-celled animals will come under phylum *Protozoa*. Therefore :

1. If the **animal has psuedopods**, (whether blunt and short or fine and long) has no hard shell then it belongs to *class Rhizopoda*.

Now observe the psuedopodia. If they are blunt and short and there is clear distinction between ecto and endoplasm, it belongs to order Lobosa and the animal may be *Amoeba*. Compare other details from a book diagram.

2. If the protozoan **has cilia on its body** and has **mega** and **micro nuclei** then it belong to class Ciliophora. If the cilia are small, equal sized, all over the body.

(*a*) Then it belongs to order Holotricha and may be *Paramecium*. Compare shape and other details like gullet, undulating membrane etc.

(*b*) If the ciliate has large oral cilia in a clockwise spiral, and small cilia on rest of the body, then it belongs to order Heterotricha and may be *Nyctotherus* or *Stentor*. Compare shape and other details.

(*c*) If the ciliate is sessile (attached to leaf blades) has a bell-shaped body with a long contractile stalk for attachment, large oral cilia in anti-clockwise spiral, rest of the body generally without cilia, then the order is *Peritricha* and the ciliates may be *Vorticella* or Epistylis. Compare details.

3. If the protozoan **has no cilia**, no psuedopodia, but **one or two flegella**, and the body covered by pellicle, sometimes with chromatophores, then the protozoan belongs to class Mastigophora or flagellata.

If the flagellate has one flagellum, a thick pellicle, gullet, distinct, green chromatophores then it belongs to order Euglenoidea and the animal may be *Euglena* or *Copromonas*. Compare details.

PLANARIA

(Turbellaria or freshwater flat worms)

Habitat : Widely distributed found in all ponds and streams. Are found attached to under surfaces of stones etc. away from light. May vary in length from 1/8 inch to 1/2 inch or more. In colour, very from white-brown-black. Common colour is dark grey.

Collection : Ordinary jars, cans with lids will do. Upon visiting a pond or stream, turn over stones, boards, sticks and examine their under

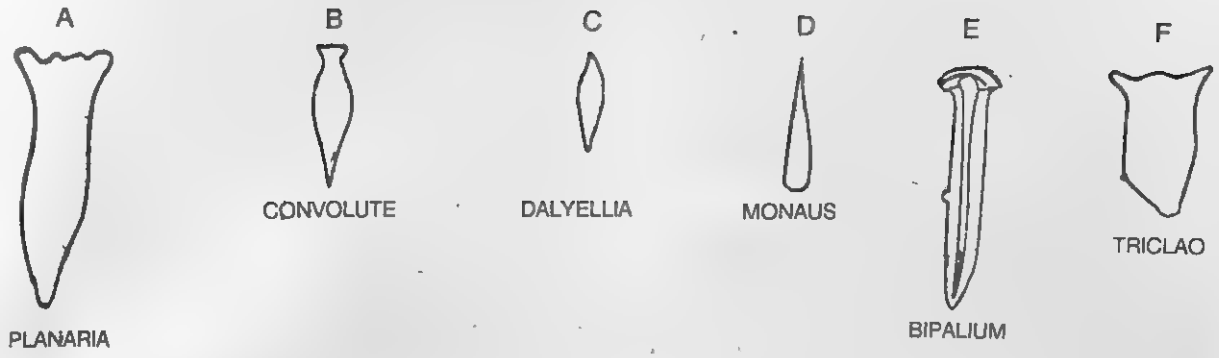


Fig. 11.6 : Different types of Planarians

surfaces. Usually they will be found in clusters. They may be washed off into a bucket or jar, or transferred upon the point of a pen knife. The jars then must be kept closed or they will crawl out.

Culturing : They may be kept in aquaria which should have stones and mud at the bottom and lot of plant material. A simpler method is to place them in a shallow dish with 1 inch of fresh water. Cover the dish to exclude light. Feed them 2-3 times a week on a slice of liver kept in the pan. They will all cluster around it. After one hour, they can be lifted off the food with a blunt knife edge. They can be observed under a microscope by placing one gently on a dry slide and covering it with another slide. They offer excellent material for studying process of regeneration.

Preservation : Place one or more worms in-between two slides. Press enough to flatten them but not crush them. Tie the slides and place them in a shallow dish or pan. Pour a solution of 5% Formalin. Tilt the slides and let the fixative run in-between the slides. Allow the material to remain submerged for 2 hours or more. Remove from fromalin, they can be preserved as such or can be transferred to vials. By this method, they are flattened for useful microscopic observation. Some common shapes of different Turbellarians are as follows :

Identifying features :

(*i*) Bilaterally symmetrical

(*ii*) Dorsoventrally compressed
(Phylum Platyhelminthes)

Nonparasitic, with ciliated, cellular epidermis-(*class Turbellaria*).

Turbellaria with elongated depressed body, amterior tentacular appendages ; intestine has a medium anterior divison and two posterior limbs (Order Tricladida).

Examples—Planaria, Triclad.

EARTHWORMS

Habitat : Moist soil abundant in decomposing vegetable matter ; in warm manure piles. Digging up moist soil with spade or turning over an old manure pile will yield earthworms. In rainy seasons, when their burrows get water-logged, they come out in open puddles on wet streets or garden lawns and drives and can be very easily collected.

Collection : These worms can be hand-picked and put straight away in bottles or jars containing moist soil with vegetable debris. Blunt forceps can be used but best is to use your fingers and firmly lift up the worm.

Culturing : Keep them in soil containing lot of humus, in a large box (shoe box) or garbage can

with many holes in the bottom. The holes must be very small so that the worms cannot get out through them. The container must be kept in dark moist place in temperature, range of 45°-65°F. Use humus, scattered dead leaves in the soil for food.

Preserving : can be killed by slowly heating in water or by anesthetizing in alcohol. The first method involves placing them in water and heating slowly, until worms are limp and motionless. Second method involves adding alcohol to the water little at a time until same results are obtained. Next lay the worm on a table. Take 6% formalin in a hypodermic syring and insert the needle into the body cavity (Do not pierce the intestinal tract) in the anterior region. Empty the syringe and repeat this again ; 10 segments behind the point of first injection. Like this, the entire body cavity has to be filled with the preservative such that the segments remain fully extended. Finally, pour enough preservative over the entire worm to cover it. Let this stand overnight and the material is preserved.

Identifying Features

Elongated, cylindrical body with external ring-shaped segmentation-*Phylum Annelida.*

Body provided with setae or bristles, dorsal blood vessel and ventral nerve cord – Class *Chaetapoda.*

Absence of parapodia, setae on each segment, head and tail ends similar, presence of anterior clitellum, terrestrial forms found in moist soil— Order *Oligochaeta.* Example Earthworms. The Indian earthworm is *Pheretima.*

INSECT

Habitat : In general insects are found everywhere, among household debris, the ponds and streams, the soil on garden plants, grass, on water surface, in sand etc. It is difficult to name an environment that does not have insects.

Collecting Equipment

1. *Cyanide bottle :* Crush some sodium cyanide and place it in small lumps in the bottom of a jar with a wide mouth and a tight lid. Over this put chopped cork or saw dust and make the surface levelled. Pour 1/2 inch of plaster of paris and set it aside to dry, when dry, close the jar, ready to be used. Label this bottle as "poison".

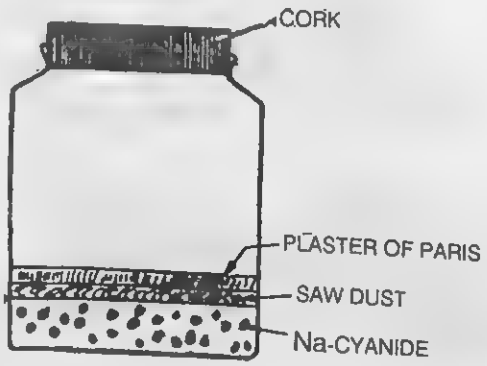


Fig. 11.8 : Cyanide bottle for killing insects.

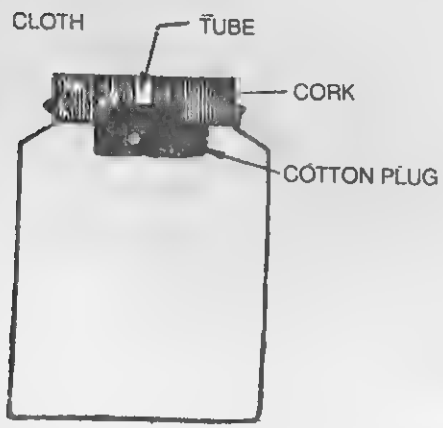


Fig. 11.7. Carbon tetrachloride bottle for killing insects.

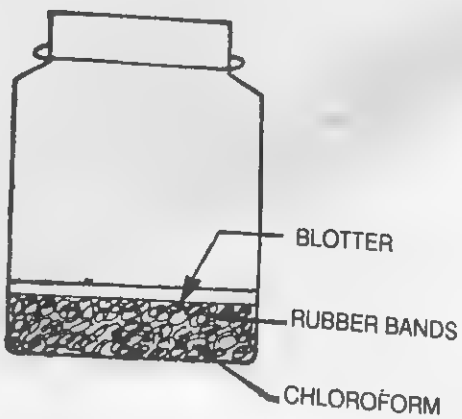


Fig. 11.9. Chloroform bottle for killing insects.

2. *Carbon terrachloride bottle :* This is a harmless and yet an efficient killer. Make a hole through the cork of the bottle. Fasten a wad of cotton to the bottom of the cork. Insert a glass tube so that it touches the cotton. Pour CCI_4 through the tube so that the cotton is wet with it. This can be easily carried. It is non-poisonous and non-explosive small bottle CCI_4 can be carried and the cotton was made wet from time to time.

3. *Chloroform bottle :* Another type of killing bottle is made by using rubber, which has a high absorbancy for chloroform. Place a small handful of rubber bands in the bottom of a jar and cover them with chloroform. Let it stand over-night. Then pour out excess chloroform and place a cardboard or a thick blotter over them. The rubber will have absorbed enough chloroform to keep the air in the bottle filled with fumes.

4. *Net :* A good and inexpensive net may be made from mosquito net cloth, sewn in the form of a long bag and fastened to a heavy wire or rod frame which is circular and extended into a handle.

5. *Sieves :* With wire bottoms are very handy on a trip when insects from water are to be collected.

6. *Vials of alcohol may be carried :* Sometimes some beetles remain alive even in a killing bottle and then have to be dipped in alcohol to be killed. A few drops of toluene on the body of the moth or butterfly will kill it immediately and since it is a very fast method, wings and scales remain

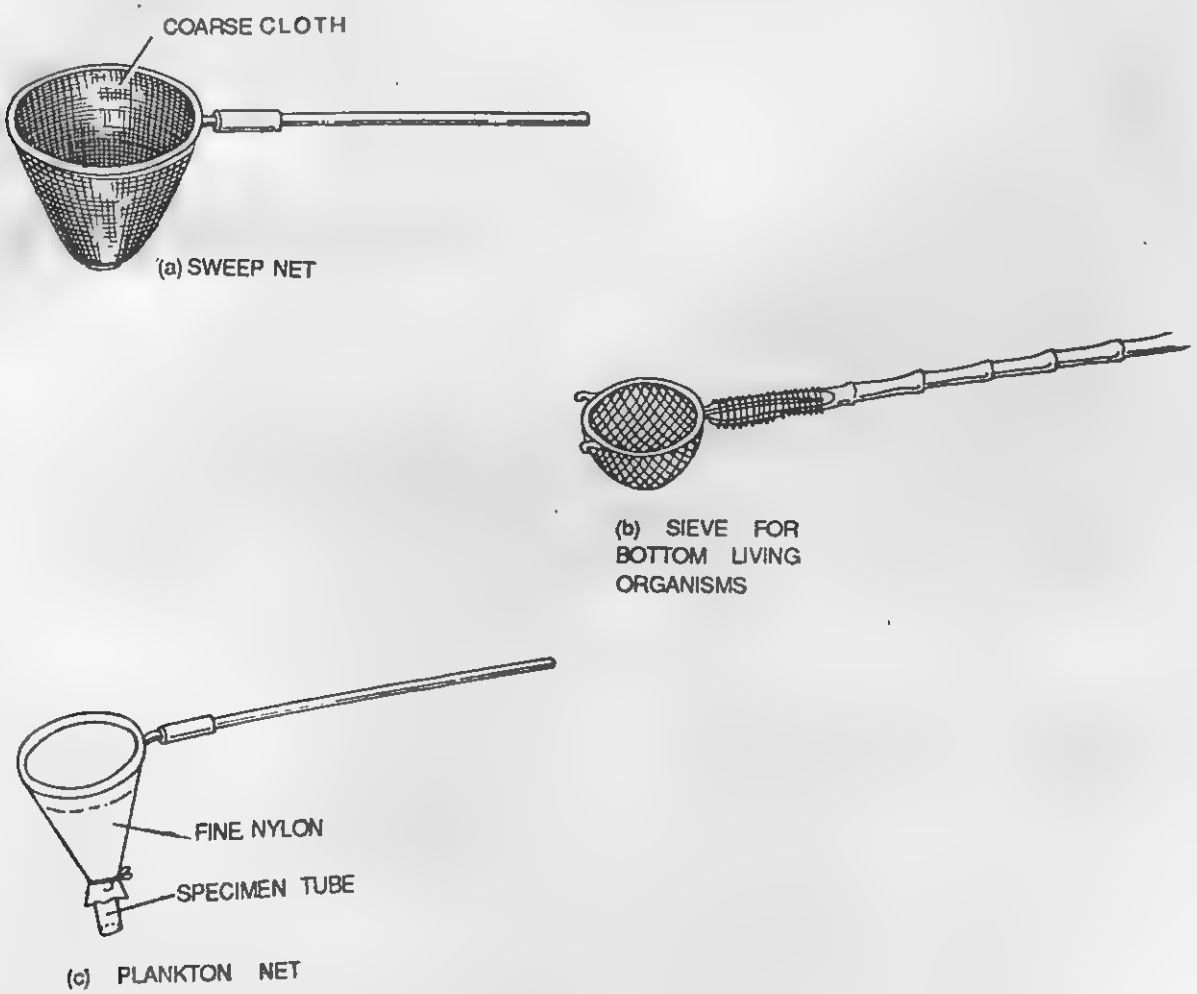


Fig. 11.10. : Nets to collect insects and aquatic animals

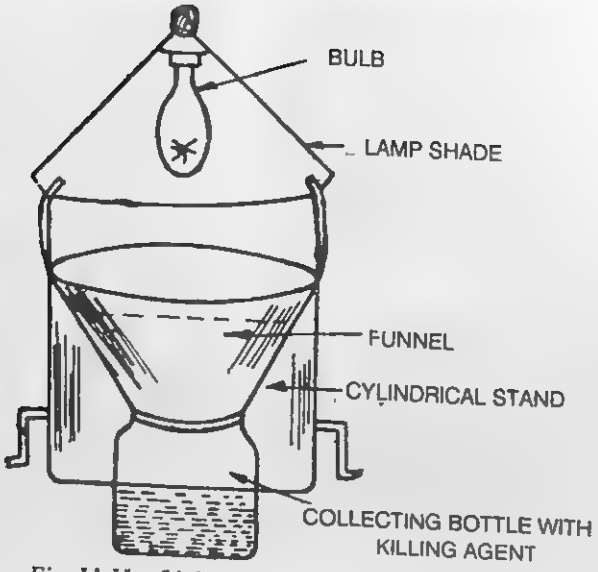


Fig. 11.11 : Light trap for collecting insects.

undamaged, which otherwise get broken by beating.

7. A light trap can be easily made for catching moths and other night flying insects.

AQUATIC FORMS

Whirligig and water striders : Found actively swimming on surface waters in warm weather. A dip net may be used to collect them and they may be kept in water or on moist surface till they reach the labortaory. Beneath the water surface, diving beetles and water bugs are found. Dip net may be used to collect these too.

Flying above the water, or in its neighbourhood, resting lightly on the nearby vegetation are found graceful, airplane-like insects—the dragon flies and damselflies. These are very active and need a swift sweeping movement of the net to be entrapped.

Feeding upon tender parts of stems, leaves, flowers are found various types of insects and their caterpillar larvae.

Bees and butterflies can be found in blossoming season among flowers. Everybody is familiar with common household pests such as cockroaches, ants, mosquitoes and house flies. We all know where to find them. Many of these are scavengers and therefore can be trapped inside jars containing baits in the form of left over foods. These are only few of the insects that can be easily collected.

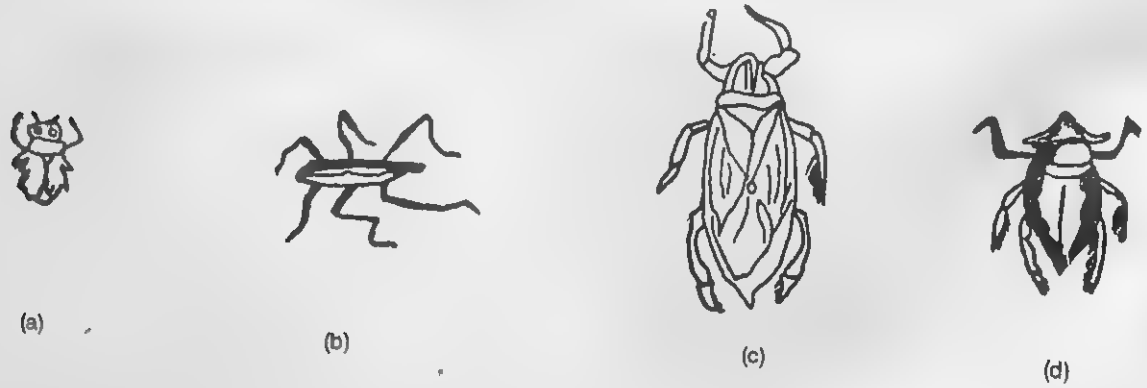


Fig. 11.12. Some aquatic insects

a = Whirligig beetle *b = Warter Strider* *c = Giant water bug* *d = Diving beetle*

Preservation : The most universal method of preserving any insect is thrusting a pin through the body of the insect after it is killed and before it is dried. In the process of drying, preferably in an incubator it gets firmly fastened to the pin. Usually the pin is put through thorax, in case of a beetle it is put through the wing cover. Butterflies, moths and grass hoppers are spread before drying on a spreading board. Very small insects that can't be pinned are glued on paper.

Spreading can also be done by using very small pins. The wings spreaded and pinned until dried.

After the insects are dried, they are kept, mounted as shown inside collection boxes that have a cork base or card board base and a cover of transparent material, either glass or cellophane paper. If, sometimes insects are too dry and britle

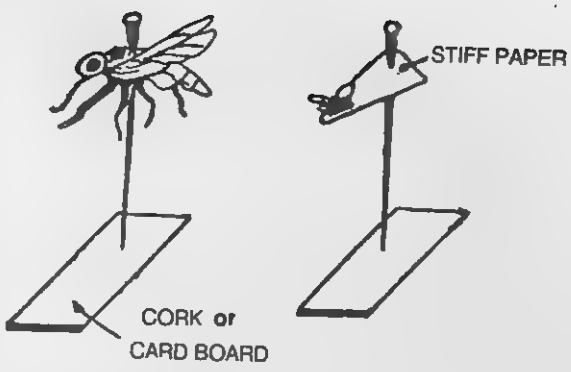


Fig. 11.13. : Mounting of in insects insect box.

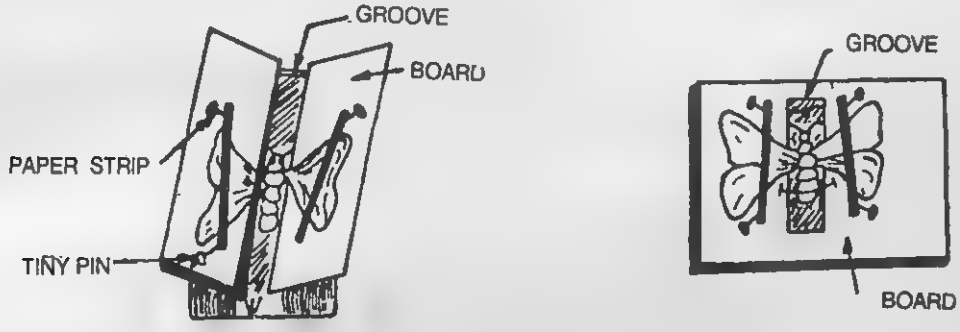


Fig. 11.14. : Diagram to show spreading of wings of insects for dry collection.

to be spread, then they can be softened. Place them inside a jar containing water and a platform. The air in the jar becomes saturated with water and the insect absorbs moisture. In 24 hours, it has absorbed enough to become soft and now can be spread. This is known as a "relaxing chamber". Small amount of carbolic acid is added to prevent mould growth on specimens.

Inside the collection box, put naphthalene balls to ward off other pests that might destroy the insects.

Preserving colours : Very often there is a loss of bright colour of caterpillars. This can be

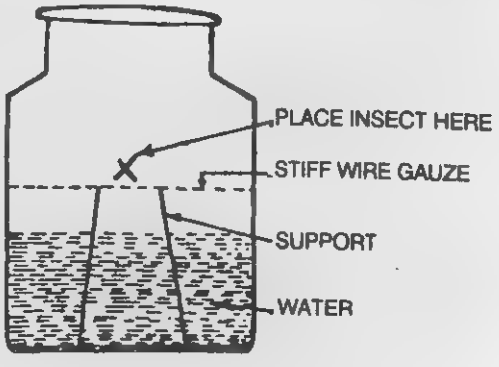


Fig. 11.15. : Relaxing chamber.

avoided by adding some $CuSO_4$ or Cuperic chloride in the formalin or alcohol in which the animal is kept. Allow them to remain for several days and then remove. The bright green colour of caterpillar gets the extra green of Cu salt and it remains longer.

Identification : Any body can identify an insect to its phylum and class level *i.e.*, Phylum Arthropoda and Class Insecta. A few orders, their identifying features and examples are given below to help students :

1. *Order Orthoptera :* Two pairs of wings, anterior pair harder and opaque, posterior delicate and can be folded up beneath the anterior pair. Biting mouth parts *e.g* : Grass hoppers, Locusts, Crickets, Stick and leaf Insects, Preying Mantis, Cockroaches.

2. *Order Isoptera :* Social and polymorphic form; society composed of winged and wingless individuals, the former are sexual and later are the sterile workers. Biting mouth parts. e.g., white ants.

3. *Order Odonata :* Two equal pairs of wings antennae very short, very large eyes, biting mouth parts. e.g., dragon flies.

4. *Order Lepidoptera :* Scaly wings, mouth parts in the form of a sucking tube rolled up spirally. Larvae typicak caterpillars. e.g., butterflies and moths.

5. *Order Coleoptera :* Anterior wing pair as hard, horny wing cases, the elytra, cover the membranous, folded posterior wings. Very well developed jaws for biting and chewing, e.g., all true beetles.

6. *Order Hymenoptera :* Both pairs of wings are membranous. Mouth parts for biting and licking. Larvae are legless. e.g., bees, wasps, ants.

7. *Order Diptera:* Single pair of transparent wings *i.e.* anterior. Posterior wings are modified into halteres. Mouthparts for piercing and sucking or licking. Larvae legless. e.g., house flies, Mosquitoes.

FISH

Habitat : Creeks, rivers, pond, lake all contain fish.

Collection : Use a net for small fishes like Minnows, Guppies etc. Baits can be set by spreading bread crumbs on the water over the net. When the Minnows are feeding lift the net quickly.

Preservation : Leave them in a 5% solution of formalin for about a week, and then transfer them to a fresh 5 to 6% formalin solution. Make sure to slit the ventral wall or puncture it at several places so that the preservative enters the interior. Addition of a 15% glycerine to the preservative prevents the fish from becoming very stiff.

Identification : Student should on his own identify a fish as belonging to Phylum Chordata, sub phylum Vertebrata and class Pisces (Look up chapter on Identification). Check whether the fish is cartilaginous or bony for there are very well defined external differences between them. Commonly available fishes are :

(1) Labeo
(2) Catla
(3) Mystus (Singhara)
(4) Clarias (magur)

AMPHIBIA

Habitat : Ponds, swamps, damp grassy lands are good sources for frogs. Toads live on dry lands and are available in the garden.

Collection : These have to be approached cautiously and captured individually, with the help of a cotton duster, for frogs are slippery animals. A hand net with long handle may help. Frogs are easily caught at night by flashing torch light beam upon them, which makes them unable to move and can be caught.

Preservation : Make a slit in the body wall ventrally. Dip in 7% formalin mixed with 15% glycerin for softening.

Identification : Frog is a chordate, subphylum Vertebrata and belongs to class Amphibia.

(1) Body slimy, triangular head, no neck and no tail.
(2) Fore limbs shorter than hind limbs.
(3) Skin colour greenish black dorsally, pale yellow on ventral side.
(4) Large eyes on top of head.

Birds and Mammals

Preservation of these involve thorough knowledge of taxidermy, embalming etc. The student if interested would have to refer to specific texts and obtain help and guidance from some experienced taxidermist.

Significance of collection of Plants and Animals

By making field trips one learns interesting things about plants and animals in their natural habitat. It helps in observing the adaptations of living beings to their environment and way of living. It also gives an opportunity to apply one's theoretical knowledge in actual field situation.

Key for collection of some common animals

S. No.	Name	Habitat	Collection
		Protozoans	
1.	*Amoeba*	Freshwater ponds, pools ditches (in rainy season)	Collect water and aquatic plants in a beaker
2.	*Paramecium*	Freshwater ponds, pools ditches (in rainy season)	Same
3.	*Euglena*	Same It forms a green scum on water surface	Collect scuns and water in a beaker
		Sponges	
4.	*Fresh water sponge*	From freshwater ponds, pools and lakes	Cut its pieces with a sharp knife or scapled
5.	*Marine sponges*	From sea shores	Same
		Coelenterates	
6.	*Hydra*	Ponds, lakes, ditches	Collect water and aquatic plants. Hydra remains attached to leaves of water weeds
7.	*Aurelia*	From sea water	
		Helminthes	
8.	*Tapeworm*	Butcher's place (from intestine of sheep, goat and dog) or from rats intestine	Pulle out with force
9.	*Fasciola (Liver fluke)*	From Butchers place(from liver of sheep)	Pulle out with force
10.	*Ascaris*	From intestine of dog, pig, cat and man.	
		Annelids	
11.	*Earthworm*	In rainy season these can be collected from lawns and fields	
		Arthropods	
12.	*Insects*	From fields or gardens	With insect net
13.	*Crustaceans*	From freshwater or from shallow sea bottoms ; some can be seen crawling on sea shores.	To be handled with long forceps
		Molluscs	
14.	Shells	From sea-shores	With the help of forceps
15.	Ponds snails	From ponds and river	
16.	Garden slug	During rainy season, these crawl on moist ground	
		Fishes	
17.	Fresh water fishes	From ponds and rivers	With the help of net

FIELD TRIPS OR EXCURSIONS

Importance of Field Trips

Collection of various kinds of animals and plants and their preservation enables students to know a wide variety of plants and animals, their habitat, behaviour and structure etc. This also helps in understanding the interdependence between plants and animals. The effect of environment on living beings structural, and physiological adaptations to environment, and also the mechanism of evolution. For collection of plants and animals field trips are planned to nearby fields, gardens, hill stations, sea coasts, or to wild life sanctuaries, zoological parks and botanical gardens etc.

Planning of A Trip

Trips or excursion should be planned carefully. The site of excursion should be selected according to the requirement. The duration should be decided upon the type of study. Students shall know in advance where they are going and what shall they be collecting.

Students shall be told to make necessary preparation for setting out for the trip. They must carry their personal belongings along with all necessory materials, equipments, chemicals etc., which are required for collecting animals and plants. These have already been discussed in respective heads.

ORAL QUESTIONS

Q. 1. *What is herbarium ?*

Ans. Herbarium is a collection of preserved angiosperm plants which are pressed, dried and are mounted on sheets and are arranged in sequence according to some specific system of classification.

Q. 2. *Which system of classification is followed for plant classification ?*

Ans. Benthum and Hooker system of classification is adopted in India.

Q. 3. *What is size of herbarium sheets?*

Ans. The standard size of herbarium sheet is 28 cm × 40 cm.

Q. 4. *What percentage of formalin is used in preservation of animals ?*

Ans. 5–8% formalin solution is used for preserving animal.

Q. 5. *What essential equipments are required for collection of angiosperm plants when you are on a local field trip*

Ans. Vasculum, polythene bags, small shears, sharp knife, forceps, hand lens, old newspapers, wide mouth bottle.

□□

CORE EXPERIMENT 12

IDENTIFICATION OF ANIMALS

IDENTIFICATION OF AMOEBA, PARAMECIUM, HYDRA, LIVER FLUKE, ASCARIS, LEECH, EARTHWORM, PRAWN, CRAB, SILKWORM, HONEYBEE, ANT, SPIDER, SHARK, ROHU, ANABAS, FROG, TOAD, CALOTES (LIZARD), SPARROW, PIGEON, GUINEA PIG, RABBIT.

Aim : To identify, classify and comment on the important characters of organisms listed above.

Material Required

Record file, pencil-H, eraser, sharpner, ruler and a laboratory guide or practical book.

Fresh or preserved specimens.

Method

1. Have some good practical guidebook and come prepared in the calss for the study.

2. Listen carefully the instructions imparted to you in the beginning of the class and note down the important identifying features told to you.

3. Observe and study the specimens and try to identify the features told to you.

4. Draw directly from the specimen or slide, showing all the details.

5. Select appropriate scale of magnification. Keep a proportion of length and width.

6. Make your drawings large enough to show the necessary details legibly.

7. First sketch the outline with a light hand. Keep the symmetry and proportion. When it comes out to be correct, darken the outlines. Draw the details which could be seen in the specimen.

8. Take the help of practical guidebook to check the correctness of the diagram and labelling its various parts.

9. Draw only what is visible to you. Do not sketch the elaborate diagrams from the book.

10. Do not shade the diagram or give any artistic effect. A neat and correct diagram with distinct illustrations is always appreciated.

11. Label on either side of the diagram symmetrically with straight parallel lines. Write legibly and preferably in block letters. Take care that the lines of labels are not crossing.

12. Use only right side of the page for sketching. Put ruled papers in between drawing sheets for writing down the comments.

13. For complete specimens give classification on the top of the diagram towards right side.

14. Before starting the sketching work, put date on one corner of the page. At the top of the page in the middle give main heading of the work.

CLASSIFICATION

1. **Taxonomy** is the branch of biology that deals with the classification and naming of living and extinct organisms.

2. **Species** is the basic unit of biological classification. A species is a group of one kind of organisms which are able to interbreed among

themselves but are reproductively isolated from other such groups.

3. Classification of organisms and their division into various categories is based on degree of resemblance between species or groups of species.

4. CAROLUS LINNAEUS is called *'father of taxonomy'* because he introduced :

(i) Binomial nomenclature

(ii) System of classifying organisms into identical groups.

Five Kingdom Classification

Initially all organisms were divided into two kingdoms :

1. Animal kingdom

2. Plant kingdom

WHITTAKER 1969 suggested new five kingdom arrangement of organisms based on the

1. Complexity of cell structure

2. Complexity of organisms body

3. Mode of obtaining nutrition

These five kingdoms are :

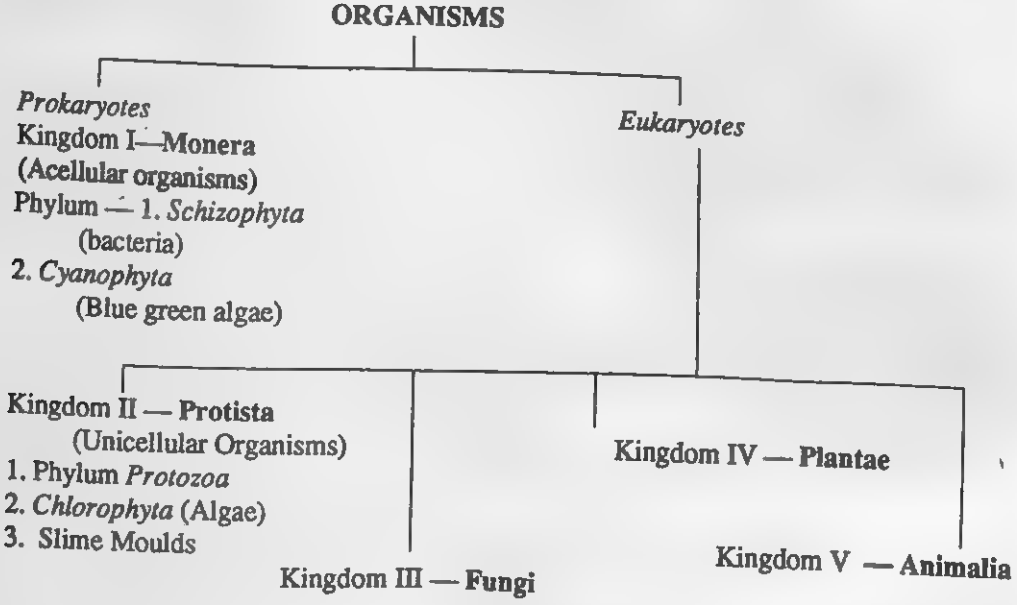
1. Kingdom — **Monera** (*G. monos* = single)

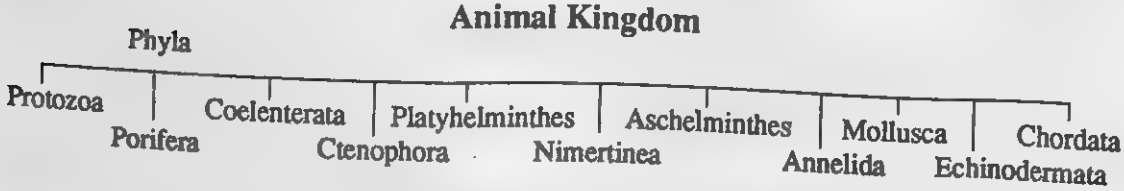
2. Kingdom — **Protista** (*G. protos* = primary)

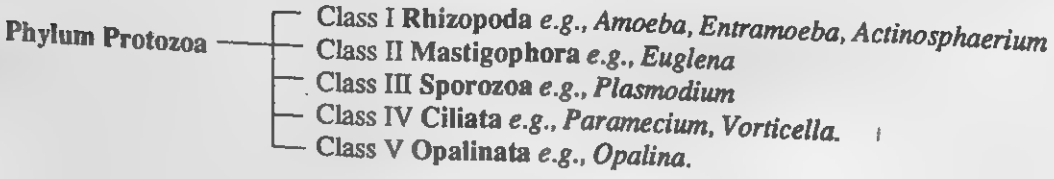
3. Kingdom — **Plantae**

4. Kingdom — **Fungi**

5. Kingdom — **Animalia**







- **Phylum Porifera**
  - Class I **Calcarea** *e.g., Sycon*
  - Class II **Hexactinellida** *e.g., Euplectella*
  - Class III **Demospongiae** *e.g., Euspongia (Spongia)*
- **Phylum Coelenterata**
  - Class I **Hydrozoa** *e.g., Hydra*
  - Class II **Scyphozoa** *e.g., Aurelia*
  - Class III **Anthozoa** *e.g., Corals*
- **Phylum Platyhelminthes**
  - Class I **Turbellaria** *e.g., Planaria*
  - Class II **Termatoda** *e.g., Fasciola*
  - Class III **Cestoda** *e.g., Taenia*
- **Phylum Aschelminthes**
  - Class I **Rotifera** *e.g., Rotifera*
  - Class II **Gastrotricaha** *e.g., Macrodasya*
  - Class III **Echinodera** *e.g., Echinoderes*
  - Class IV **Priapulida** *e.g., Priapulus*
  - Class V **Nematoda** *e.g., Ascaris, Filaria*
  - Class VI **Nematomorpha** *e.g.., Gordius*
- **Phylum Annelida**
  - Class I **Oligochaeta** *e.g., Pheretima*
  - Class II **Polychaeta** *e.g., Serpula*
  - Class III **Hirudinea** *e.g., Hirudinaria*
- **Phylum Mollusca**
  - Class I **Monoplacophora** *e.g., Neopilina*
  - Class II **Polyplacophora** *e.g., Chiton*
  - Class III **Aplacophora** *e.g., Neominia*
  - Class IV **Scaphopoda** *e.g. Dentalium*
  - Class V **Gastropoda** *e.g. Pila*
  - Class VI **Pelecypoda** *e.g. Unio*
  - Class VII **Cephalopoda** *e.g., Octopus*
- **Phylum Arthropoda**
  - Class I **Crustacea** *e.g., Crab*
  - Class II **Insecta** *e.g., Cockroach, mosquito, housefly, butterfly, etc.*
  - Class III **Myriapoda** *e.g., Centipedes*
  - Class IV **Arachnida** *e.g., Scorpion*
- **Phylum Chordata**
  - Sub-phylum I **Urochordata**
  - Sub-phylum II **Cephalochordata**
  - Sub-phylum III **Vertebrata**
    - Class I **Pisces** *e.g.*, Fishes
    - Class II **Amphibia** *e.g.*, Toad and Frog
    - Class III **Reptillia** *e.g.*, Snake, turtle, crocodile, lizard, etc.
    - Class IV **Aves** *e.g.*, birds
    - Class V **Mammalia** *e.g.*, Bat, elephant, human being, etc.

1. AMOEBA

Classification

Phylum —*Protozoa*
Class —*Rhizopodea or Sarcodina*
Genus —*Amoeba*

Comments

1. Unicellular organism, having simplest organisation (*Ph. Protozoa*).

2. Amoeboid in form with pseudopodia as locomotory organelle (*Cl. Sarcodina*)

3. Body naked without pellicle and pseudopodia of lobopodia type.

Characteristics

1. Found in fresh water of ponds, pools, ditches where decaying vegetation is abundant.

2. Body colourless, body form irregular, everchanging.

3. Body naked without pellicle and exoskeleton.

4. Protoplasm differentiated into *ectoplasm* and *endoplasm*.

5. *Pseudopodia* blunt and finger-like (lobopodia).

6. Mouth and anus are absent.

7. Nucleus single.

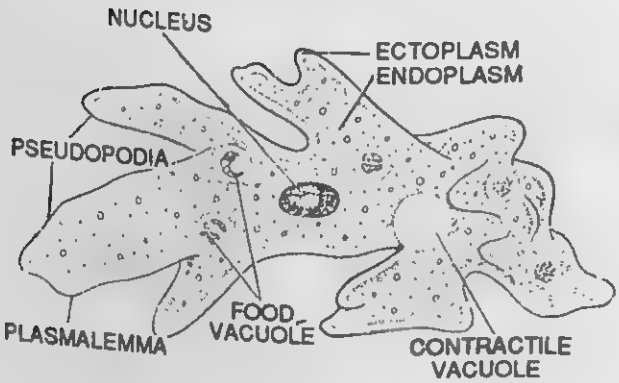


Fig. 12.1. Amoeba proteus as seen under the microscope.

Diagnostic Characters

Body shape irregular ; blunt finger-like pseudopodia; presence of food vacuole.

2. PARAMECIUM

Classification

Phylum — *Protozoa*
Class —*Ciliata*
Genus — *Paramecium*

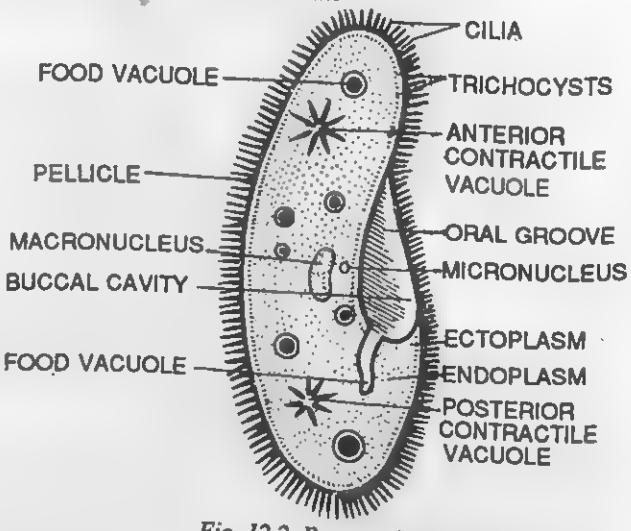


Fig. 12.2. Paramecium

Comments

1. Unicellular organisms with simplest organization (Phylum - Protozoa).

2. Locomotory organs are cilia and possess two types of nuclei (Class - Ciliata).

Characteristics

Habit, Habitat and Distribution—Fresh-water ciliate, found in ponds and ditches rich in dead organic matter.

Comments

1. Body cigar-shaped or slipper-shaped **(slipper-animalcule)**.

2. Body covered uniformly with **cilia** which help in swimming and locomotion.

3. **Nuclei** two : One **macronucleus** or vegetative nucleus and one **micronucleus** or reproductive nucleus.

4. **Oral groove** ventral and extends obliquely

backward about the middle of body and leads into the cytopharynx through cytostome.

5. Ectoplasm contains **trichocysts, myonemes and basal granules of cilia.**

6. Endoplasm contains kidney-shaped **macronucleus** and rounded **micronucleus,** two **contractile vacuoles** with radiating canals and a number of **food vacuoles.**

7. Nutrition **holozoic,** feed upon bacteria, diatoms and other small organisms.

8. Reproduction by **binary fission, conjugation, endomixis, cytogamy, autogamy** and **hemixis.**

Identification—By a *slipper-shaped body* and two contractile vacuoles.

3. HYDRA

Classification

Phylum —*Coelenterata*
Class — *Hydrozoa*
Order — *Hydroidea*
Type — *Hydra*

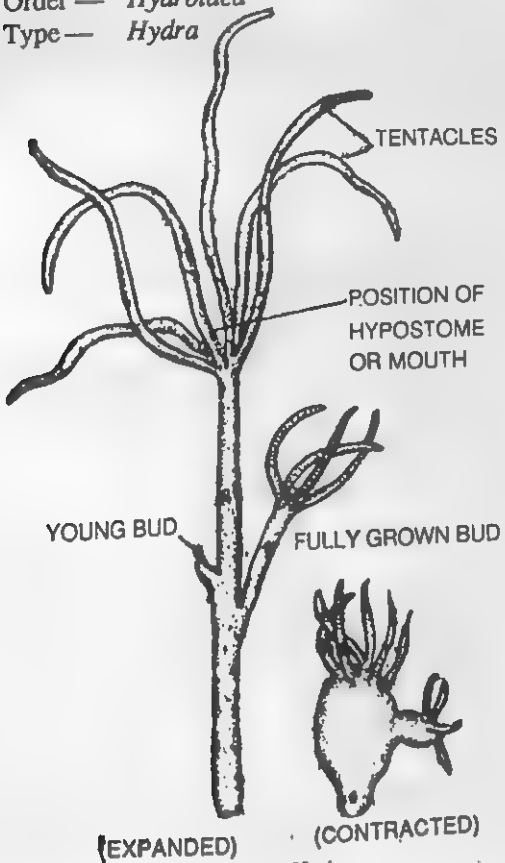


Fig. 12.3. Hydra

Comments

1. Diploblastic acoelomate with gastrovascular cavity and tissue grade of construction; possess nematoblast cells (Phylum *Coelenterata*).

2. Mesogloea acellular, stomodaeum and gastric filaments absent, includes both polypoid and medusoid phases (Class *Hydrozoa*).

3. Exposkeleton absent; polypoid generation is well developed.

Habit and Habitat — Found attached to submerged objects in fresh-water pond, pools and ditches.

Characteristics

1. Body radially-symmetrical, soft and cylindrical and hollow.

2. Anterior end produced into a conical hypostome bearing mouth and a circlet of hollow tentacles.

3. Distal end modified into **basal disc** meant for attachment.

4. Mature *Hydra* may bear a **bud** at the base and **gonads** in the middle of body.

5. Tentacles and hypostome bear **nematoblasts** or stinging cells.

6. Body wall **diploblastic** with outer layer of **ectoderm** and inner **endoderm.**

Diagnostic Characters

1. Tubular, with tentacles around mouth.

4. FASCIOLA
(Liver fluke)

Classification

Phylum — *Platyhelminthes*
Class — *Trematoda*
Order — *Digenea*

Comments

1. Triploblastic, bilaterally-symmetrical, acoelomate worms with dorso-ventrally flattened body (*Platyhelminthes*).

2. Adhesive organs **suckers** (*Trematoda*).

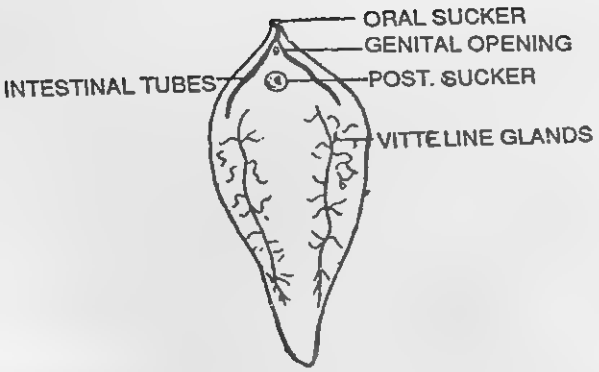


Fig. 12.4. Fasciola

3. Possess two suckers (*Digenea*).

Habit and Habitat—Endoparasite in the bile-passage of liver of vertebrates, hence commonly known as *'liver fluke'*. *F. hepatica* is found in sheep and *F. gigantica* in man.

Characteristics

1. Body **dorso-ventrally flattened** and leaf-like with both **oral** and **ventral** suckers.

2. **Mouth** situated at the anterior end and surrounded by oral sucker.

3. Excretory pore lies at the posterior end of the body.

4. **Gonopore** ventral situated in front of ventral sucker.

5. **Opening of Laurer's canal** develops during breeding season on the dorsal side.

6. Stained slide presents two highly branched **testes** with tandem arrangement, one ovary and numerous vitelline glands placed laterally.

7. Life-history includes **snail** as an intermediate host and exhibits a number of **larval stages.**

8. **Pathogenecity**—Causes 'liver-rot', eosinophilia, anemia and diarrhoea.

5. ASCARIS
(Round Worm)

Classification

Phylum — *Nemathelminthes or Aschelminthes*
Class — *Nematada*
Genus — *Ascaris*

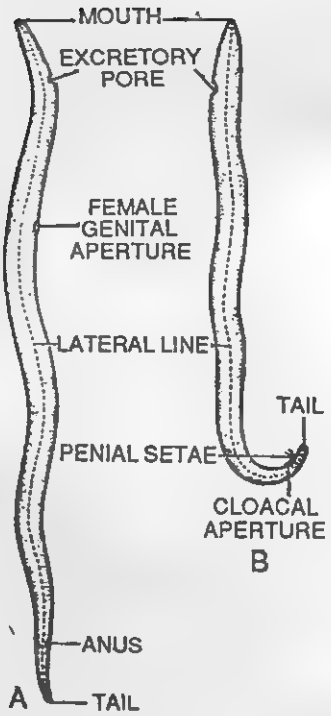


Fig. 12.5. Ascaris A—Female; B—Male.

Comments

Unsegmented, cylindrical, worm-like pseudocoelomate (*Aschelminthes*).

Habit and Habitat—Endoparasite in the small intestine of man and is more common in children. Cosmopolitan in distribution.

Characteristics

1. Body elongated, cylindrical and pointed at both ends.

2. Body surface **transversely striated** and presents **pseudosegmented appearance.**

3. A **dorsal**, a **ventral**, and two **lateral lines** extend lengthwise.

4. **Excretory pore** anterior and mid-ventral in position.

5. Exhibits **sexual dimorphism.**

6. Life-history simple without intermediate host; infection occurs through contaminated water and raw vegetables.

7. Heavy infection causes **temperature, colic pain, indigestion, loss of appetite** and **anemia, etc.**

Male:

(i) Smaller in size.

(ii) **Posterior end curved.**

(iii) Male genital aperture and anus open into **cloaca** and the cloacal opening is posterior in position.

(iv) A pair of **penial setae** project out of the genital aperture.

Female:

(i) Female is comparatively longer

(ii) **Posterior end is straight.**

(iii) **Female gonopore** or vulva lies at a distance of about anterior 1/3 of the length of the body.

(iv) **Cloaca and penial setae are absent.**

6. HIRUDINARIA
(Leech)

Classification

Phylum — *Annelida*
Class — *Hirudinea*

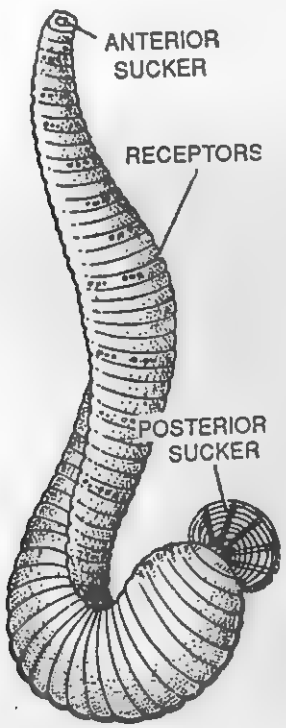


Fig. 12.6. Leech

Comments

1. Bilaterally-symmetrical, triploblastic and metamerically segmented coelomate worms (Phylum *Annelida*).

2. Body without setae and parapodia but with suckers (Class *Hirudinea*).

Habit and Habitat—Lives in freshwater ponds and streams and leads an **ectoparasite** life on cattle.

Characteristics

1. Body elongated, dorso-ventrally flattened.

2. **Body** divided into 33 segments differentiated into 5 regions:

(i) **cephalic,**
(ii) **preclitellar,**
(iii) **clitellar,**
(iv) **caudal,**
(v) **middle,** and
(vi) **psterior sucker.**

3. Both anterior and posterior suckers present.

4. **Mouth** ventral and triradiate aperture; anus dorsal.

5. **Sanguivorous** (feeds on blood of vertebrates).

6. Saliva contains *anticoagulin* which prevents clotting of host's blood while leech is sucking blood.

Economic importance—Leeches are **sanguivorous** in habit. In olden days these were used by the physicians to suck impure blood **(Phleobotomy).** *Hirudo medicinalis* is still imported from Europe for removing black and blue spots around the eyes. These can suck blood three times their own weight in a single meal and can survive for even six months without another meal.

7. PHERETIMA
(Earthworm)

Classification

Phylum — *Annelida*
Class — *Oligochaeta*
Type — *Pheretima*

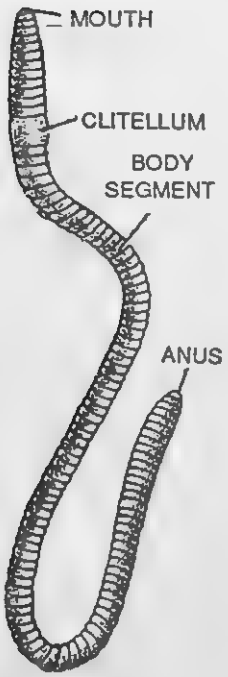


Fig. 12.7. Earthworm

Comments

1. Bilaterally symmetrical, metamerically segmented, coelomate worm (*Annelida*).

2. Setae embedded in the integument and are enclosed in setal sacs (Class - *Oligochaeta*).

Habit and Habitat—Found burrowing in moist sand or mud all over the world.

Characteristics

1. Body elongated, **cylindrical** and pointed at both ends. It is adopted for burrowing.

2. Body is metamerically segmented, consisting of about 120 metameres (segments).

3. **Prostomium** reduced, forms upper lip and hangs in front of mouth.

4. **Clitellum** present in 14th, 15th and 16th segments.

5. A ring of setae present in each segment except the first and last segment.

6. **Female genital aperture** unpaired and present in 14th segment but **male genital apertures** are paired and present in 18th segment.

7. Earthworms are great friends of farmers because while burrowing, they turn over much of the surface soil. This leads to ploughing and proper aeration of soil.

8. PALAEMON
(Prawn)

Classification

Phylum — *Arthropoda*
Class — *Crustacea*
Type — *Palaemon* (Prawn)

Comments

1. Bilaterally symmetrical triploblastic animal, having an exoskeleton of chitin (*Phylum Arthropoda*).

2. Limbs jointed (*Ph. Arthropoda*).

3. Chitinous exoskeleton is hard being impregnated with lime salts (*Cl. Crustacea*).

4. Body distinguished into *cephalothorax* and *abdomen* (*Cl. Crustacea*).

5, Each segment of the body carries a pair of appendages (*Cl. Crustacea*).

Habit and Habitat—Found in ponds, lakes and rivers etc.

Characteristics

1. Body spindle-shaped and distinguished into cephalothorax and abdomen.

2. **Cephalothorax** formed by the fusion of 5-segmented **head** and 8-segmented **thorax.**

3. **Carapace** produced anteriorly into serrated **rostrum.**

4. Head appendages are 5 pairs—two pairs of **antennae,** a pair of **mandibles** and two pairs of **maxillae.**

5. Walking legs five pairs, first two pairs of them are **chelate legs.**

6. 2nd chelate leg in male is longer and stronger.

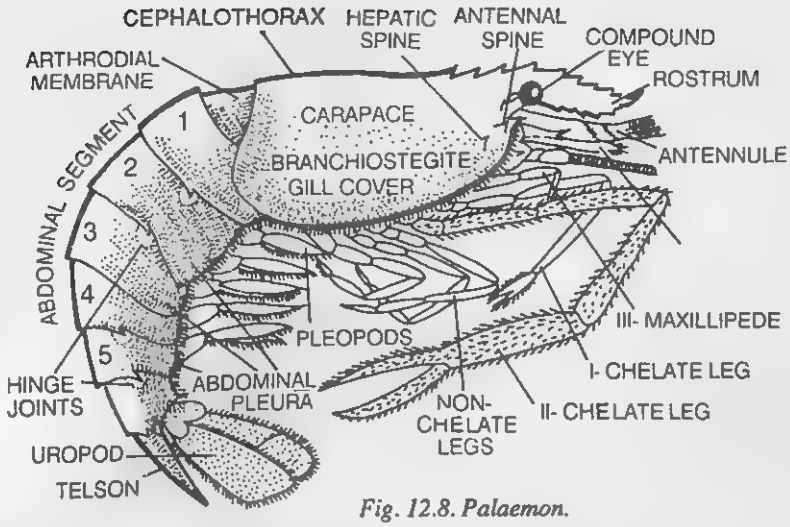


Fig. 12.8. Palaemon.

9. CARCINUS
(Crab)

Classification

Phylum — *Arthropoda*

Class — *Crustacea*

Type — *Carcinus* (Crab)

Comments

Same as in *Palaemon.*

Habit and Habitat—Found buried among rocks or mud in shallow water.

Characteristics

1. **Cephalothorax** broad and somewhat oval with a broad carapace.

2. **Abdomen** reduced and is permanently flexed below cephalothorax.

3. Antennules, antennae and eyes small and contained in sockets of carapace.

4. Third maxillipedes broad, flat and plate-like.

5. Walking legs five pairs; only first pair of **walking legs are chelate.**

6. Male with two pairs of **pleopods**, whereas female possesses four pairs of them; uropods absent.

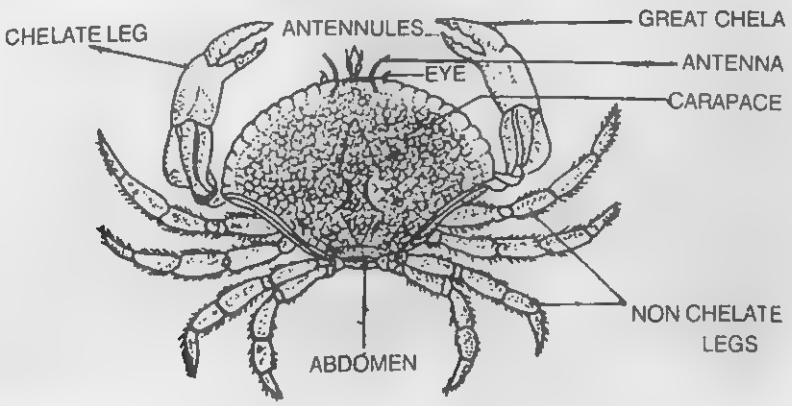


Fig. 12.9. Corcinus.

10. BOMBYX MORI
(Silk moth)

Classification

Phylum —*Arthropoda*
Class —*Insecta*
Type —*Silk moth.*

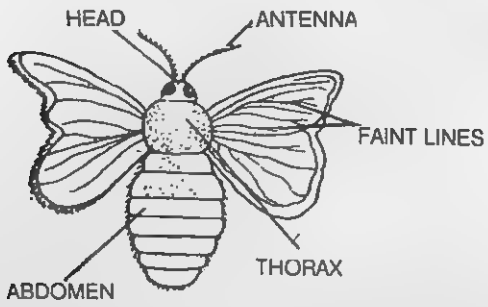


Fig. 12.10. Silk moth.

Comments

1. Chitinous exoskeleton around the body and jointed appendages (Phylum *Arthropoda*).

2. With 3 pairs of walking legs and two pairs of wings (Class — *Insecta*).

Habit and Habitat

1. Aerial insect, lays its egges or mulberry leaves.

Characteristics

1. Body broad and stumpy.

2. Antennae are short, thick and bipectinate.

3. Legs hairy and spurless.

4. Mouthparts *siphoning* type, but adult is without proboscis and does not feed.

5. Nocturnal.

6. Wings are held horizontally in resting condition.

7. **Economic Importance—Silk moth,** *Bombyx mori*, is commercially important because silk is obtained from its silken cocoons. Common cloth moth is *Tinea pellionella.*

11. APIS
(Honey bee)

Classification

Phylum — *Arthropoda*
Class — *Insecta*
Order — *Hymenoptera*

Comments

1. Body covered with exoskeleton and with jointed appendages (Phylum — *Arthropoda*).

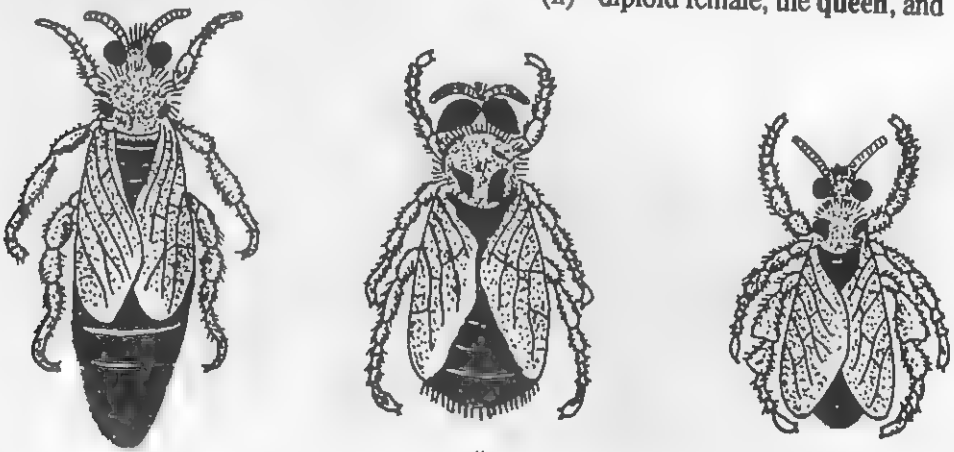
2. Possess 3 pairs of walking legs and two pairs of wings (Class—*Insecta*).

Habit and Habitat—Social and colonial insect.

Characteristics

1. **The colony** consists of —

(i) diploid sterile **workers,**
(ii) diploid female, the **queen,** and



I-Queen bee, II - Worker, III - Drone

Fig. 12.11. Apis (Honey bee).

(iii) haploid males or drones developing parthenogenetically from unfertilized eggs.

2. **Mouthparts** and legs modified for collecting **nectar** and **pollen from flower.**

3. Hindlegs possess **pollen bakset** and midlegs have **pollen brush.**

4. Female possesses **sting.**

5. **Economic Importance**—These collect pollens and from them manufacture **wax** and **honey,** which have great medicinal value. These **pollinate flowers** while collecting nectar. Without this fruits and many types of crops could not grow.

12. ANT

Classification

Phylum — *Arthropoda*
Class — *Insecta*
Type — *Ant*

Comments

1. Limbs jointed, body covered with chitinous exoskeleton (*Arthropoda*).

2. Walking legs 3 pairs and wings two pairs (*Insecta*).

Characteristics

1. Social insect, exhibits polymorphism and caste system — workers, soldiers, nurses, king and queen etc.

2. The mouthparts adapted for both biting and sucking.

3. It has large head and slender oval abdomen joined to the thorax by a small waist.

Fig. 12.12 Typical ant.

4. The mouth has two sets of jaws.

5. The reproductive ants have wing.

6. The females are frequently equipped with a sting at the posterior end.

13. SPIDER

Classification

Phylum — *Arthropoda*
Class — *Arachnida*
Genus — *Argiope*

Comments

1. Limbs jointed, body covered with chitinous exoskeleton (Phylum — *Arthropoda*).

2. Body differentiated into **prosoma** and **opisthosoma** (*Cl. Arachnida*).

3. Six pairs of appendages of which there are 4 pairs of walking legs (*Cl. Arachnida*).

4. True jaws or mandibles absent (*Cl. Arachnia*).

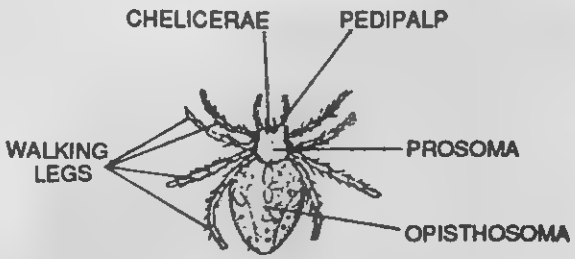


Fig. 12.13. Spider

Habit and Habitat— Found on trees, grasses and shady corners all over the world.

Characteristics

1. Prosoma with simple eyes and 6 pairs of appendages :

(i) a pair of subchelate **chelicerae.**
(ii) a pair of nonchelate **pedipalps.**
(iii) a pair of **walking legs.**

2. **Opisthosoma** unsegmented and without appendages and telson, but with three pairs of spinnerets.

3. Poison glands open on the fangs of chelicerae.

4. Sexual dimorphism distinct. Female is large and usually eats up male after copulation.

5. Economic Importance—Spiders are beneficial since they prey upon harmful insects.

Spinneret possesses opening of spinning glands which are used in spinning the web and capturing the prey. Spiders are poisonous and their bite is followed by pain and fever. These spin web and wait for the prey to get entangled. The prey is then injected a poisonous and digestive juice and the digested juice is sucked up. The eggs are enclosed in a silken sac which is hung among grasses near the web.

14. PILA
(Snail or Apple Snail)

Classification

Phylum — *Mollusca*
Class — *Gastropoda*
Genus — *Pila*

Comments

1. Body soft, segmented and enclosed in a calcareous shell (*Phylum Mollusca*).

2. Shell univalved and coiled.

3. Head distinct with eyes and tentacles (Class — *Gastropoda*).

Habit and Habitat—Found in fresh water in ponds, pools, tanks and rice fields. In winter *Pila* hibernates in the mud.

Characteristics

1. Commonly known as **apple snail.**

2. **Shell** univalve, globose and spirally coiled, consisting of $6\frac{1}{2}$ whorls. The whorls are demarcated by **sutures.**

3. **Shell surface** is marked with **lines of growth.**

4. **Operculum** present and closes the shell opening.

5. **Head** with two pairs of tentacles and one pair of eyes.

6. Kindey and gill unpaired and part of mantle modified into **pulmonary sac**, adapted to aerial **respiration.**

7. Foot anterior and ventral, broad and sole-like used **for creeping.**

8. Feeds on aquatic plants.

15. UNIO
(Bivalvia)

Classification

Phylum — *Mollusca*
Class — Pelecypoda
Type — Unio

Comments

1. Body soft, unsegmented and enclosed in a calcareous shell (Phylum — *Mollusca*).

2. Shell bivalved, head rudimentary (Class *Pelecypoda*).

Habit and Habitat—Found buried in the mud in freshwater ponds, pools, lakes and rivers.

Comments

1. Commonly known as **feshwater mussel.**

2. Shell valves two, equal and jointed dorsally by hinge ligament.

3. **Umbo** situated near the anterior end of the

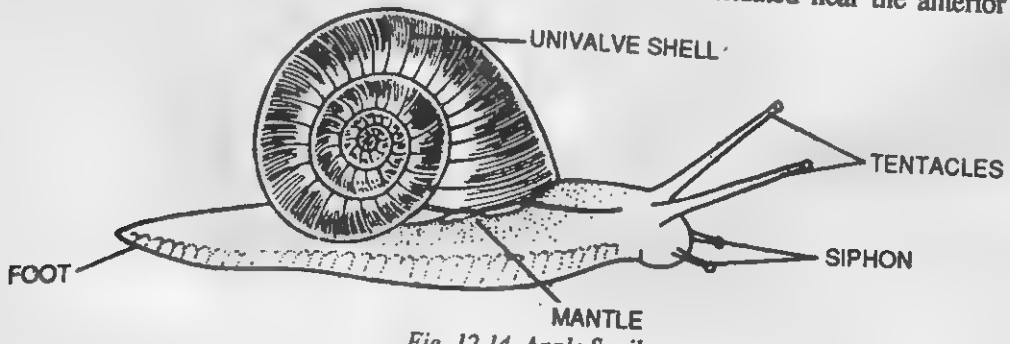


Fig. 12.14. Apple Snail

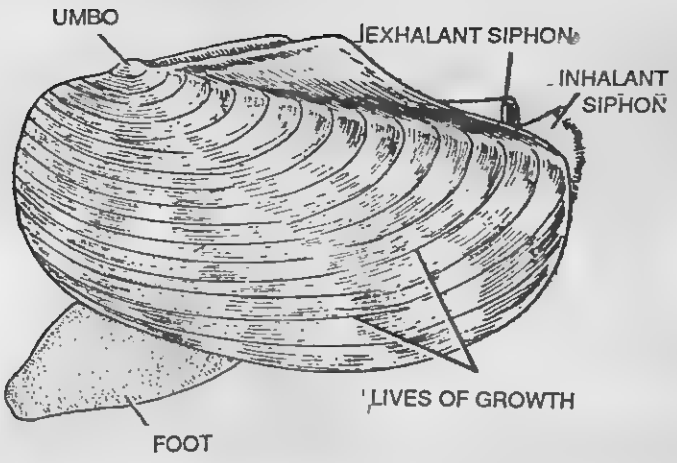


Fig. 12.15 Unio.

dorsal side.

4. Two mantle flaps form exhalent and inhalent siphons at the posterior end of body.

5. Foot large, muscular and tongue-shaped used for burrowing.

6. Adductor muscles two, anterior and posterior which regulate the opening and closing of valves.

7. Two bipectinate gills, one on either side of the visceral mass present.

16. SLUG

Classification

Phylum — *Mollusca*

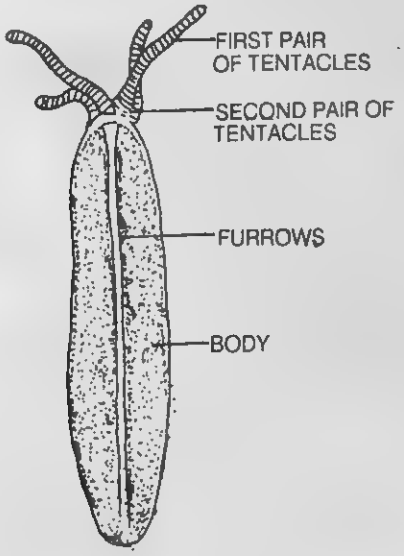


Fig. 12.16 Vaginulus.

Class — Gastropoda
Type — Vaginulus (Garden slug)

Habit and Habitat—Found on land in damp soil and among fallen leaves.

Comments

1. Body elongated with flattened ventral and convex dorsal surface.

2. Body has undergone detorsion.

3. Shell secondarily lost.

4. Cephalic region with two pairs of retractile tentacles.

5. Eyes present at the tip of second pair of tentacles.

6. Pulmonary cavity reduced and anteriorly placed. It opens to the exterior by a duct at the posterior end of body.

7. A furrow extends on the ventral side of the body.

8. Hermaphrodite. Male genital opening lies beneath the right posterior tentacle and the female genital opening lies in the middle of body on the right side.

17. ASTERIAS
(Star Fish)

Classification

Phylum — *Echinodermata*

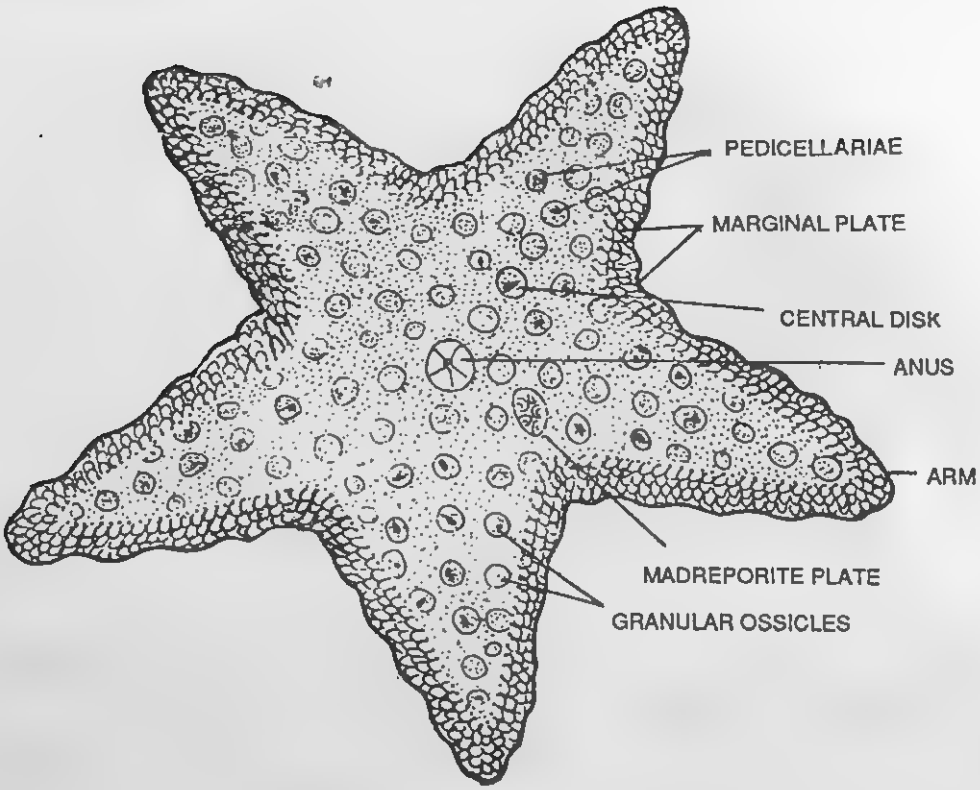


Fig. 17: Star fish.. Dorsal view

Subphylum — *Eleutherozoa*
Class — *Asteroidea*

Comments

1. Pentaradiate coelomates with spiny skin and water vascular system (Phylum *Echinodermata*).

2. Body star-shaped; bases of the arms not distinctly marked off from the disc; arms broad, hollow; open ambulacral grooves with tube feet (Class — *Asteroidea*).

3. Pedicellariae forcipulate and pedunculate; marginal plate inconspicuous; papullae scattered all over the body and tube feet in four rows.

Habit and Habitat—Star-fishes are found crawling on rocky sea bottoms in shallow water.

Comments

1. **Body star-shaped,** consisting of a central disc with five radiating arms.

2. **Bases of arms broad** and not marked off from the central disc.

3. **Oral surface** directed downwards and bears mouth.

4. **Mouth** pentagonal and in the centre of oral surface of the disc.

5. Five **ambulacral grooves** radiate from five corners of the mouth and extend to the tips of arms.

6. **Four rows of tube feet** : Two rows along either margin of ambulacral groove. Tube feet have **terminal sucker** and help in locomotion.

8. **Aboral surface** bears large number of short, stout spines arranged in irregular rows.

9. **Dermal branchiae** or **papullae** are scattered among the spines.

10. **Madreporitae** situated on the aboral surface between the bases of two arms.

11. **Anus** on the aboral surface, present in the centre of the disc.

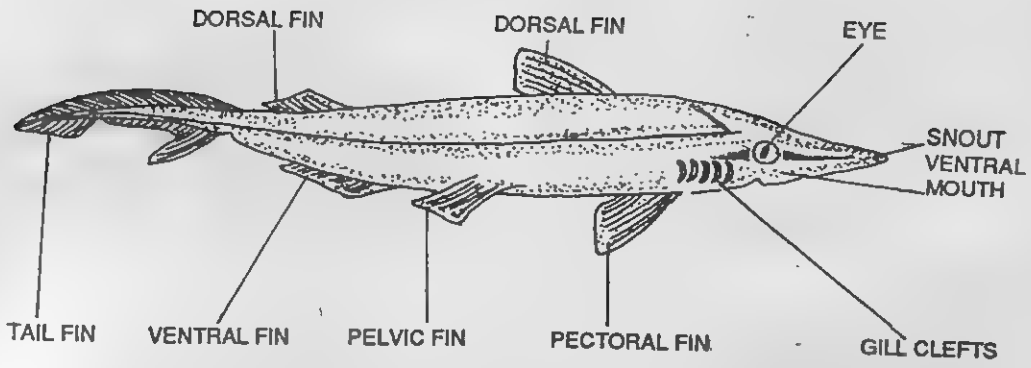


Fig. 12.18. Dog fish

18. SCOLIODON

(Dog fish — Shark)

Classification

Phylum — *Chordata*
Subphylum — *Vertebrata*
Superclass — *Gnathestomata*
Division — *Pisces*
Class — *Chondrichthyes*

Comments

1. Vertebral column in the form of cartilaginous rings constricted from the notochord (*Chondrichthyes*).

2. Notochord persist in the centre (*Chondrichthyes*).

3. Head distinct with sense organs (*Chondrichthyes*).

4. The anterior part of the nerve cord enlarged to form brain.

5. Endoskeleton is cartilaginous (*Chondrichthyes*).

6. Exoskeleton of placoid scales, embedded in the integument.

7. Mouth supported by jaws and spiracles in front of mouth.

8. Paired appendages in the form of pectoral and pelvic fins.

9. Median fins also present.

10. Gill-slits 5 pairs and lateral in position.

Dogfish, commonly known as the shark, is found in the coastal waters of India. It has a

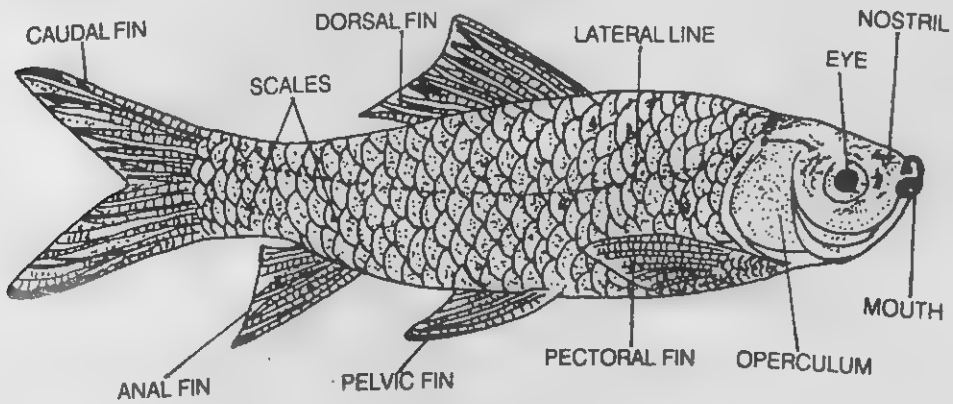


Fig. 12·19 Labeo rohita (Bony fish).

fusiform body with pointd snout. The mouth is crescentic with sharp inwardly curved and pointed teeth. The body is differentiated into head, trunk and tail. The tail is heterocercal. Two dorsal, an anal and a caudal fin present. Male possesses claspers. Sharks are voracious feeders.

19. LABEO ROHITA
(Bony Fish)

Classification

Phylum — *Chordata*
Class — *Osteichthyes*
Genus — *Labeo*
Species — *Rohita*

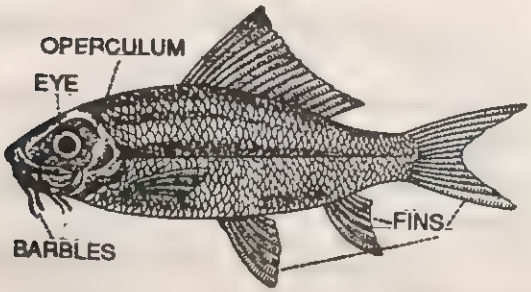


Fig. : 12.20

Comments

1. It is found abundantly in ponds and rivers.
2. The body is laterally compressed and is covered with overlapping cycloid scales.
3. Mouth is terminal in position. A pair of nostrils and median eyes are present.
4. There are five pairs of gill slits covered by an operculum.
5. Paired appendages are in the form of fins for locomotion.
6. Tail homocercal with a fin.
7. Skeleton is bony.
8. Lateral line sense organs are present.
9. **Economic Importance**—Used as food fish.

20. ANABAS
(Climbing perch)

Classification

Phylum — *Chordata*
Subphylum — *Vertebrata*

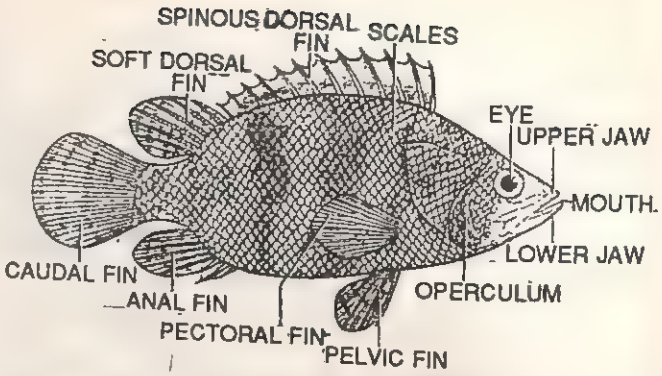


Fig. 12.21. Anabas

Division — *Gnathostomata*
Class — *Osteicthyes*

Comments

1. Brain and cranium well formed (*Vertebrata*).
2. Jaws present (*Gnathostomata*).
3. Paired appendages are fins supported by fin rays (*Pisces*).
4. Endoskeleton bony; Gills enclosed inside opercular chamber (*Osteichthyes*).

Characteristics

1. Freshwater, predatory fish.
2. Body laterally compressed and covered with cycloid and ctenoid scales.
3. Dorsal and anal fins long and spinous.
4. Opercular margin with backwardly directed spines.
5. Possess *accessory respiratory organs* in the opercular chamber.

Special Feature

Fish can breath air and can live on most ground and walk for short distances with the help of spiny operculum.

21. RANA
(Frog)

Classification

Phylum — *Chordata*
Subphylum — *Vertebrata*
Division — *Gnathostomata*
Class — *Amphibia*

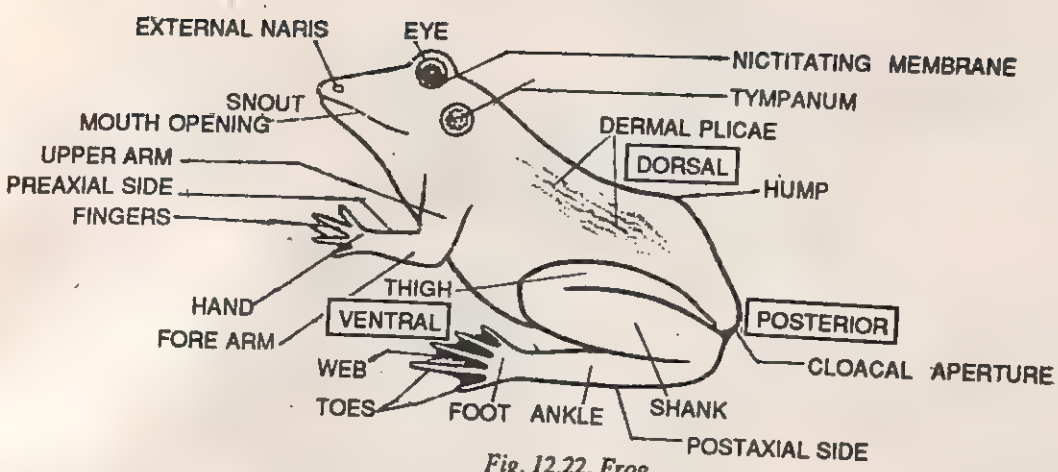


Fig. 12.22. Frog.

Comments

1. Vertebrate with true jaws (*Gnathostomata*)
2. Paired limbs 2 pairs pentactyle. Forearms with four digit and five digits in each hind leg. (Cl. Amphibia).
3. Forearms shorter than hinglegs.
4. Amphibious in nature. (Clase - *Amphibia*).
5. Digits without claws.

Characteristics

1. Skin soft and moist, helps in respiration.
2. Hindlimbs are webbed.
3. **Nictitating membrane** attached to the lower side of eye.
4. Neck and tail are absent.
5. Tongue is bifid at the distal end.

22. BUFO

(Toad)

Classification

Phylum	— *Chordata*
Subphylum	— *Vertebrata*
Division	— *Gnathostomata*
Class	— *Amphibia*
Type	— *Bufo*

Comments

1. Vertebrates with true jaws (*Gnathostomata*).
2. Paired limbs — 2 pairs. Forelimbs shorter than hind limbs.
3. Four digits in each fore limb and five in each hind limb (Class *Amphibia*).
4. Digits are without claws.

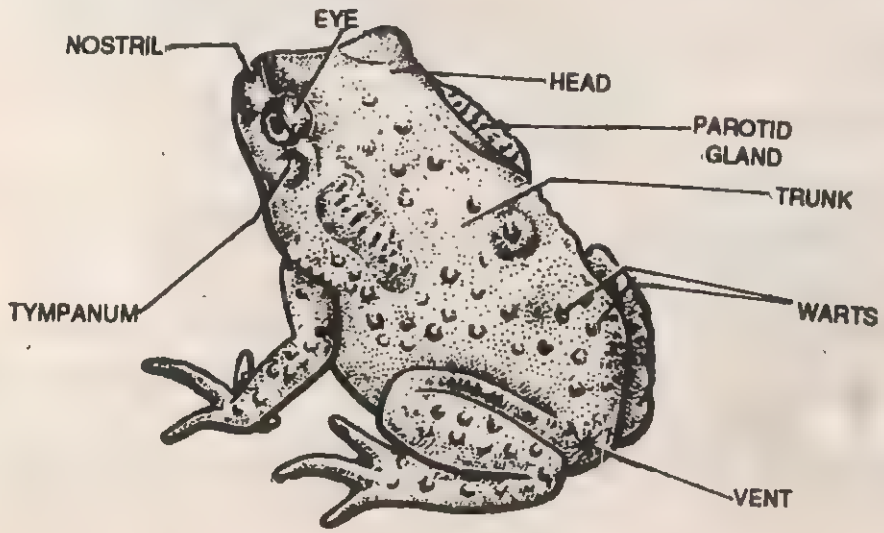


Fig. 12.23. Bufo.

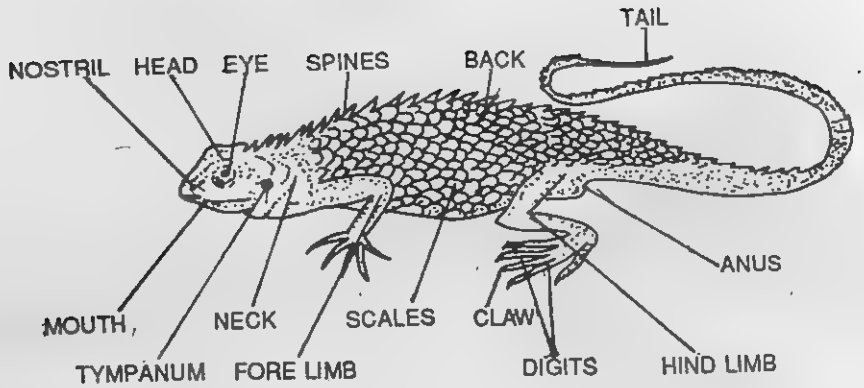


Fig. 12·24. Calotes

Characteristics

1. Lives on land only in moist and shady areas.
2. Skin is rough, dry and warty and with poison glands.
3. Limbs without web.
4. Tongue is pear-shaped and not big.

23. CALOTES
(Girgit)

Classification

Phylum —*Chordata*
Subphylum —*Vertebrata*
Division —*Gnathostomata*
Class —*Reptilia*
Order —*Squamata*

Comments

1. Vertebrates with true jaws and paired limbs. (*Vertebrata and Gnathostomata*)
2. Terrestrial, pentadactyle limbs with clawed digits.
3. Skin dry, covered with scales.
4. Eyes with movable eyelids.

Characteristics

1. Commonly known as **'girgit'.**
2. **Body** elongated and slender with an exoskeleton of overlapping scales.
3. **A crest of pointed and backwardly directed spines extends in the middorsal line** from neck to tail.
4. **Tail** very long, cylindrical and nonfragile.
5. **Head** broad and distinct and **neck** is red, hence it is also known as **blood sucker.**
6. **Limbs** pentadactyle and clawed.
8. **Exhibits colour changes, when excited.** Usually olive green but on excitement changes to yellow and neck becomes red. **The colour change is under the control of temperature, envirnoment and hormones of pituitary gland.**

24. HEMIDACTYLUS
(*Common wall lizard*)

Classification

Phylum — *Chordata*
Subphylum — *Vertebrata*
Group — *Gnathostomata*
Class — *Reptilia*

Comments

As in *Calotes.*

Characterestics

1. Commonly known as **'wall-lizard'** or **'house gecko'.**
2. About 10 inches long.
3. Skin dry and scaly. Scales are minute.
4. **Body** slender, differentiated into head, trunk and tail.
5. **Head** triangular, broad and dorsoventrally flattened.

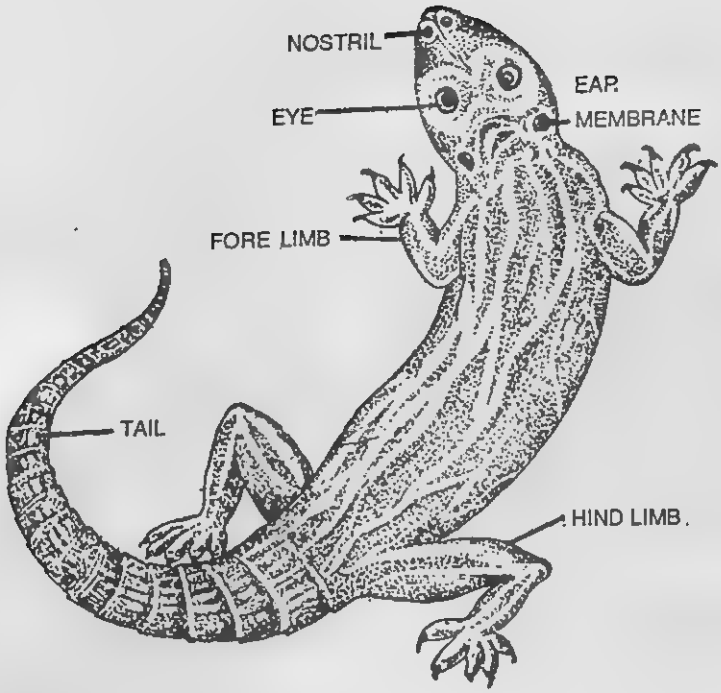


Fig. 12·25. Hemidactylus.

6. **Eyelids** are fused over the eyes and immovable.

7. **Limbs** well developed and **adapted to walk and run swiftly on smooth surfaces of walls and roof.**

8. **Digits** broad and flattened and on their undersurface are two rows of **transverse lamellae or adhesive lamellae.** These work on vacuum principle and help in getting a firm hold of the irregularities of the surface.

9. **Tail** is long, fragile and ringed. It can be **broken off with slightest pressure and the broken tail is regenerated.** The phenomenon is known as 'autotomy'.

10. **Teeth** pleurodont, help in catching the prey.

25. PASSER DOMESTICUS
(House Sparrow)

Classification

Phylum	— *Chordata*
Subphylum	— *Vertebrata*
Group	— *Gnathostomata*
Class	— *Aves*
Type	— *Passer domesticus*

Comments

1. Vertebrate with true jaws (*Gnathostomata*)
2. With two pairs of pentadactyle limbs with claws.
3. Forelimbs modified into wings (*Aves*).

Characteristics

1. Most familiar bird in India and Pakistan fond of living in human habitation and moves freely in almost every house.
2. Commonly known as **'house sparrow'** and in Hindi it is called **'Gauraiya'.**
3. Female ashy grey on the back with whitish belly.

Fig. 12·26. House Sparrow.

4. **The male has a black patch from throat to chest.**

5. **Beak** short, strong and pointed, adapted both for **seed-crushing** and **insect-eating.**

6. **Food** consists of seeds, grains, worms and small insects etc.

7. **Feet adapted for perching,** consisting of four long toes, three (2nd, 3rd and 4th) directed forward and one (1st) backward.

Economic Importance

Sparrows are useful as well as harmful. These feed on several agricultural pests and protect the crop, but these destroy the seeds, vegetables and flower buds.

26. COLUMBA LIVIA
(Pigeon)

Classification

Phylum	— *Chordata*
Subphylum	— *Vertebrata*
Group	— *Gnathostomata*
Class	— *Avas*
Genus	— *Columba*

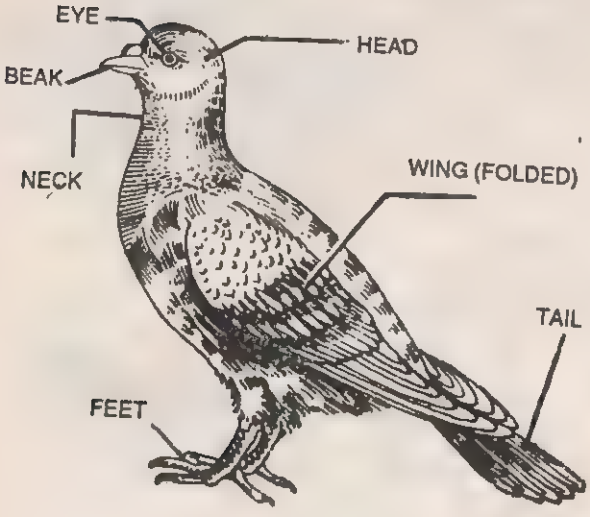


Fig. 12·27. Pigeon

Comments

As in house sparrow.

Characteristics

1. Leads **a semi-domesticated** life, living in buildings, old houses, warehouses, factory sheds, mosques and goods-yards.

2. Commonly, known as 'Kabutar' in Hindi or **blue rock pigeon.**

3. **Beak** short and slender with pointed tip **adapted for seed-crushing.** Its base is soft and membranous and is covered with **'cere'.**

4. **Feet perching type,** each with four digits, three of them (2nd, 3rd and 4th) directed forward and the first one backwards.

5. **Claws** are short and straight.

6. Feeds on cereals, pulses and groundnut.

Special Features

Pigeon exhibits social instinct. These fly in groups and roost together at night.

27. LEPUS
(Rabbit)

Classification

Phylum	— *Chordata*
Subphylum	— *Vertebrata*
Group	— *Gnathostomata*
Class	— *Mammalia*
Order	— *Lagomorpha*

Comments

1. Vertebrate with true jaws and pentadactyle limbs.

2. Body covered with hairs.

3. External ear or pinna present.

4. Females with mammary glands.

5. Heart four-chambered, warm blooded.

6. Herbivorous.

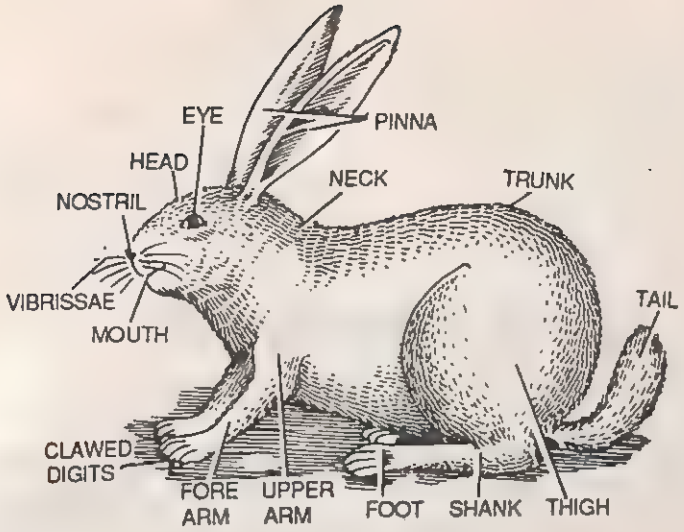


Fig. 12·28. Rabbit

7. Body divided into **head, neck, trunk**, and **tail.**

8. External ears or pinnae are large.

9. Upper lip clefted (**hare-lip**) and sensory hair or **vibrissae** present on the snout.

28. GUINEA PIG

Classification

Same as in Lepus.

Characteristics

1. Body covered with coarse fur.

2. Fore limbs longer and with 4 toes and hind limbs shorter with 3 digits only.

3. Ear or pinnae short.

4. About 11 inches in size and averages about 1 pound.

5. Head rabbit-like with short ears.

ORAL QUESTIONS

Q. 1. *What is binomial nomenclature ?*

Ans. Scientific names of all living beings (plants and animals) has two names. First name represents name of genera and second name is species name. This method of naming living beings is called binomial nomenclature.

Q. 2. *Who introduced the system of binomial nomenclature ?*

Ans. CAROLUS LINNAEUS introduced binomial nomenclature.

Q. 3. *Give two most important characters of phylum Arthropoda ?*

Ans. Arthropods have jointed limbs and nonliving, chitinous exoskeleton.

Q. 4. *Name any protozoan whose body is covered with cilia all of the same size.*

Ans. *Paramecium*

Q. 5. *Name the phylum whose individuals possess nematoblasts or cnidoblasts.*

Ans. Cnidoblasts are present only in the individuals of phylum Coelenterata.

Q. 6. *What is pseudocoel ?*

Ans. Pseudocoel is a space between body wall and body organs.

Q. 7. *Name the free swimming larvae of Fasciola.*

Ans. Miracidium or cercaria.

Q. 8. *Where is Taenia or flatworm found ?*

Ans. *Taenia* is found in the lumen of intestine.

CORE EXPERIMENT 13

IDENTIFICATION OF PLANTS

IDENTIFICATION OF BACTERIA, OSCILLATORIA, SPIROGYRA, RHIZOPUS, MUSHROOM/BRACKET FUNGI, YEAST, LIVERWORT, MOSS, FERN, THUJA (BIOTA), PINUS, ONE MONOCOTYLEDON AND ONE DICOTYLEDON, LICHENS, ROOT NODULES OF LEGUME, CUSCUTA, HYDRILLA/ELODEA, UTRICULARIA/DROSERA, CACTUS, EUPHORBIA.

Aim : Identification, Classification, and comments on some plants and viruses.

Introduction

Millions and millions of living organisms are found on this earth. These include the protists, plants and animals ranging from tiny to giant organisms. It would be rather imposible to study individual organism. Therefore, on the basis of similarities these have been divided into kingdom, phyla, orders and families etc. This is called as classification. Various systems of classification which arose from time to time are grouped into 3 main types: the artificial, natural and phylogenetic system.

1. Artificial System

In the beginning the plants were classified on the basis of few arbitrary characters. For example, *Theophrastus* (285-370 BC) *'The father of Botany'* classified the plant kingdom into herbs, shrubs, undershrubs and trees on the basis of habit. *Caesalpine* (1519-1603) classified plants on the basis of structure of fruits and seeds. *Linnaeus* (1707-1778) *'The father of Taxonomy'*, took sexual characters as the tool for the classification of plant kingdom.

2. Natural System

In this system of classification, the plants were grouped on the basis of their kinship. *Adamson* (1727-1806), *Lamack* (1744-1829), *De Jussieu* (1688-1758), and *Bentham* and *Hooker* (1800-1884) were contributors of natural system of classification.

3. Phylogenetic system :

In this system plants are grouped on the basis of evolutionary sequence and genetic relationship.

(A) *Endlicher* (1836) divided the plant kingdom into 3 subgroups :

1. *Protophyta* (Algae and Lichens)

2. *Histerophyta* (Fungi)

3. *Cormophyta* (Plants with root, stem and leaves)

(B) *Eichler* (1883) classified plant kingdom into two groups as follows :

1. *Cryptogamia* : Plants with concealed reproductive organs ; Seeds are not formed. It has been divided into 3 Divisions :

(i) Thallophyta
(ii) Bryophyta
(iii) Pteridophyta.

2. *Phanerogamia* : Plants with flowers and seeds. It has been classified into two divisions:

(i) Gymnospermae

(ii) Angiospermae

(C) *Engler* (1886) divided the plant kingdom into two, *Thallophyta* and *Embryophyta.* According to him all the plants above the level of Thallophyta were included in Embryophyta.

(D) *Otto and Towel* (1965) adopted completely new trend of classification in their book "Modern Biology". All the living organisms have been placed into 3 main kingdoms.

1. KINGDOM PROTISTA

It has been divided into two major subkingdom. It includes algae, fungi, slime molds, bacteria, viruses and some of the protozoans.

(1) Subkingdom Prokaryota

Members with primitive nucleus i.e. without nuclear membrane and nucleolus. It includes

(i) Phylum *Schizophyta* - Bacteria; (ii) Phylum *Cyanophyta* - Blue green algae.

(2) Subkingdom Eukaryota

Members with well developed nucleus. It has been divided into the following 9 phyla :

(i) Chirophyta, (ii) Charophyta, (iii) Euglenophyta, (iv) Chrysophyta, (v) Pyrrophyta, (vi) Phaeophyta, (vii) Rhodophyta, (viii) Mycophyta (ix) Myxomycophyta.

2. KINGDOM PLANTAE

It includes multicellar plants having well developed tissues and organs. Cell wall is composed of cellulose. Chlorophyll 'a' and 'b' are present in plastids. Reserve food material is starch. Multicellular sex organs are well marked. Sporophyte phase is dominent and differentiated into root, system and leaves. It has been divided into 2 phyla as follows :

(i) Phylum Bryophyta (non-vascular)
(ii) Phylum Tracheophyta (vascular)

It includes the following sub phyla :

(i) Psilopsida, (ii) Lycopsida (iii) Sphenopsida, (iv) Pteropsida

It has further been classified into 3 classes :

1. Class Filicineae
2. Class Gymnospermae
3. Class Angiospermae

3. KINGDOM ANIMALIA

It includes Invertebrates and Vertebrates.

(E) **Whittaker** (1969) placed all the living organisms into five kingdoms:

1. *Kingdom Monera*—It includes members with prokaryotic type of cellular organization e.g. Bacteria and Blue Green algae (Cynobacteria).

2. *Kingdom Protista*—It includes the eukaryotic chlorophyll bearing members e.g., Algae which have well developed nucleus and membrane bound cell organelles.

3. *Kingdom Plantae* —It includes all the plants e.g. Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

4. *Kingdom Fungi*—It includes achlorophyllous eukaryotic members e.g. Fungi.

5. *Kingdom Animalia*—It includes all animals.

1. BACTERIA

Classification

Kingdom — *Protista*
Subkingdom — *Prokaryota*
Phylum — *Schizophyta*
Order — *Eubacteriales*

Comments

1. Bacteria are simple organisms very minute in size.

2. The cells are of different shapes —

(i) Rounded bacterial cells — *Coccus* type
(ii) Rod-shaped bacterial cell—*Bacillus* type
(iii) Spiral-shaped bacterial cells — *Spirillum* type.

3. Bacteria have *prokaryotic organisation.*

4. A distinct *nucleus* and *cell organelle* are *absent.*

5. Hereditary material is in the form of a single circular chromosome, formed of DNA alone.

6. Live either as parasites, symbionts or free-living.

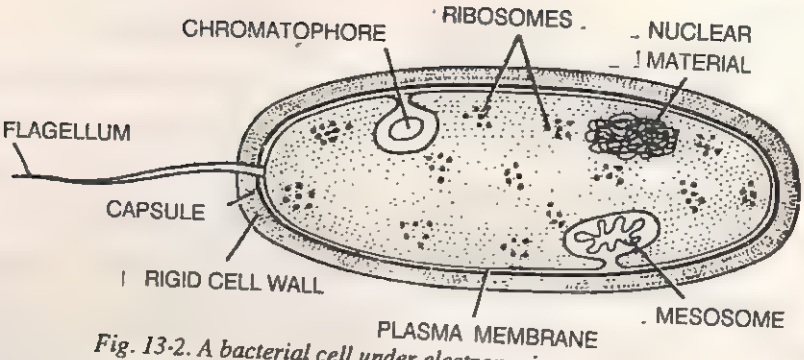


Fig. 13·2. A bacterial cell under electron microscope.

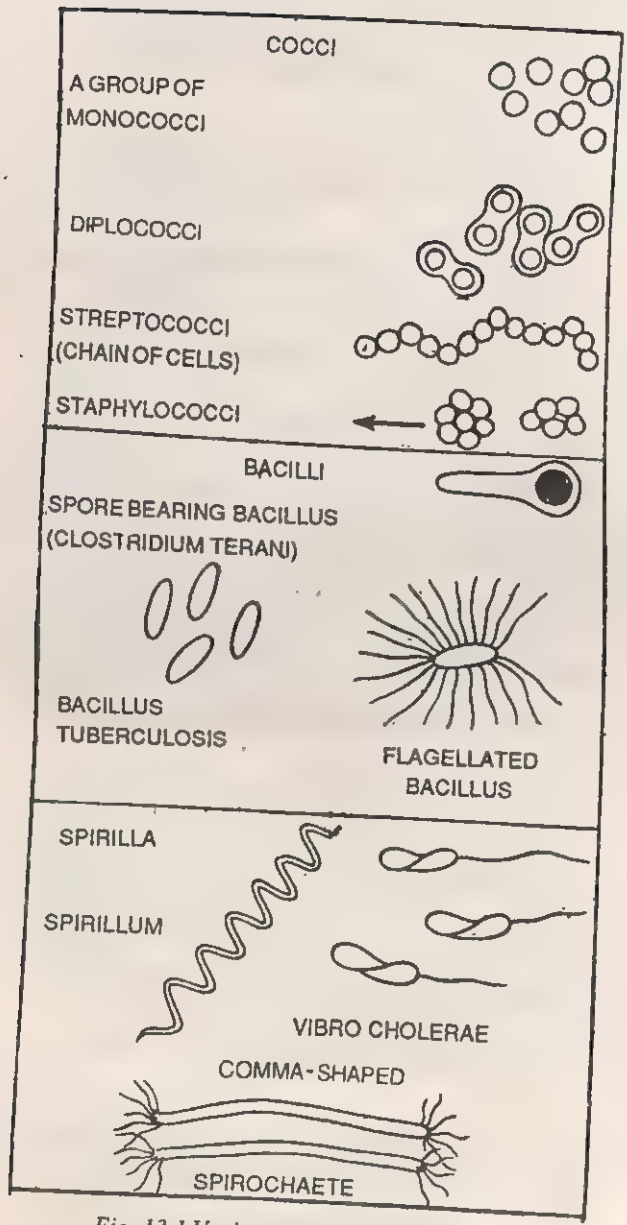


Fig. 13·1 Various types of bacteria.

7. Many of them are *pathogenic* and cause several communicable diseases in plants and animals including human beings.

8. Some bacteria are beneficial. They play important role in agriculture, medicine industry and maintaining our environment clean.

2. OSCILLATORIA
(Blue green algae)

Classification

Prokaryota (Prokaryotic organisation, Nucle·s not distinct)

Algae (Cell wall composed of cellulose simple thallus organization)

Class — *Myxophyceae* or *Cyanophyceae* (Blue green algae; reserve food in the form of granules)

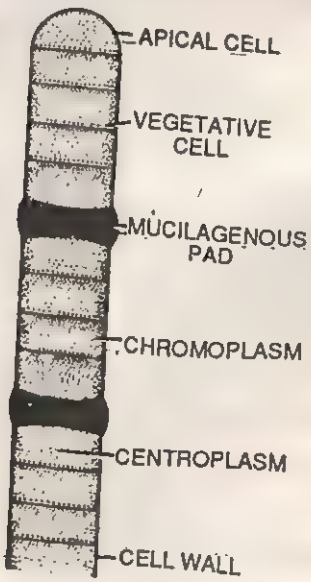


Fig. 13·3. A portion of filament of Oscillatoria.

Comments

1. Fresh water filamentous blue green algae.

2. Each *trichome* (filament) is multicellular, unbranched and cylindrical long filament.

3. Cells are *prokaryotic type*, and rectangular in shape.

4. Cytoplasm is differentiated into (i) a peripheral *chromoplasm* and (ii) central *centroplasm.*

5. *Chromoplasm* contains pigments phycocyanin (blue) and chlorophyll (green) It contains reserve food in the form of *Cyanophycean granules* (starch).

6. *Centroplasm* contains nuclear material (bacterial chromosome).

7. Apical cell of trichome is dome-shaped.

8. Tip of trichome may oscillate like pendulum (hence called *Oscillatoria*).

9. Shows gliding movement.

10. Filaments without mucilagenous sheath but with biconcave *mucilagenous pads* (separation discs).

3. SPIROGYRA

Classification

Kingdom	—*Protista*
Subkingdom	—*Eukaryota*
Phylum	—*Chlorophyta* (Algae having thallus organization)
Class	—*Chlorophyceae* (with chlorophyll and pyrenoids)

Comments

1. Plant body multicellular, filamentous, green and slimy.

2. Filaments unbranched; all cells are alike and arranged in a single row and covered with mucilage.

3. Each is elongated and cylindrical.

4. *Cell wall* composed of inner layer of *cellulose* and outer *pectic layer.*

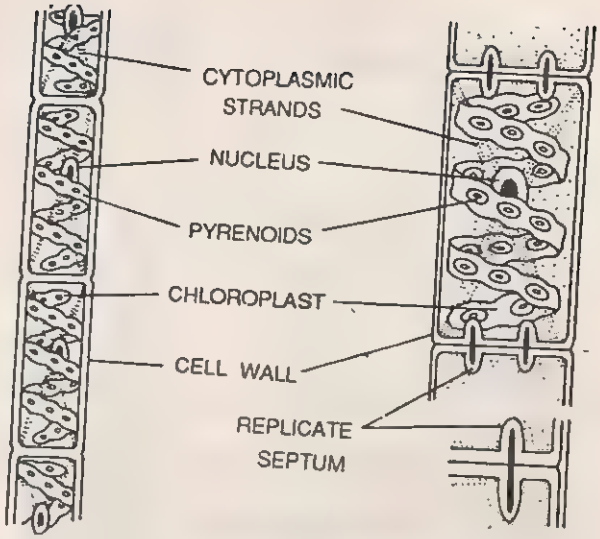


Fig. 13-4. A portion of filament of Spirogyra B. single cell enlarged.

5. *Nucleus* single and is stranded in the centre by cytoplasmic strands.

6. *Chloroplast* single, ribbon-like or band-shaped and forms a spiral.

7. *Pyrenoids* many and rounded; located on chloroplasts.

8. Sexual reproduction by conjugation.

9. Found in freshwater ponds and pools.

4. ULOTHRIX

Classification

Kingdom	—*Protista*
Subkingdom	—*Eukaryta*
Phylum	—*Chlorophyta* (Algae thallus organisation, cell wall of cellulose and chloroplasts present)
Class	—*Chlorophyceae* (Presence of chlorophyll and pyrenoids)

Comments :

1. The plant body is multicellular, filamentous and unbranched.

2. The filament consists of brick-like rectangular cells. These are of three types —

(i) Basal cell is elongated and without chloroplast. It helps in attachment with the substratum.

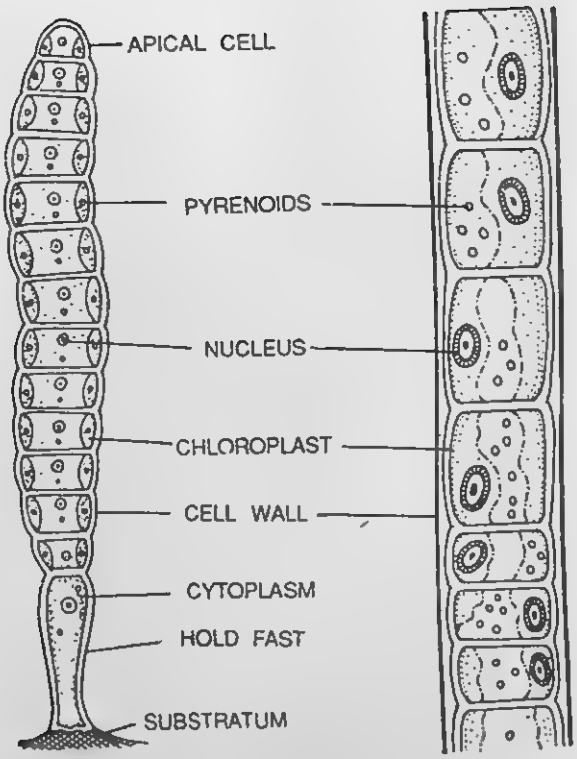


Fig. 13·5. Ulothrix - A filament and few vegetative cell showing cell structure.

(ii) Apical cell is rounded at the apex.

(iii) Intercallary cells.

3. The vegetative cell has a definite rigid cell wall, composed of inner cellulose layer and outer pectic layer.

4. Chloroplast single, large and girdle shaped or collar shaped.

5. The chloroplast bears many pyrenoids.

5. RHIZOPUS

Classification

Kingdom —*Myocota or Fungi*
Division —*Eumyocophyta*
Class —*Zygomycetes* (Mycelia aseptate and coenocytic); *Mucorales* (Sporangium with sterile columella; saprophytic); *Rhizopus* (Sporangiophores arise in groups).

Comments

1. The plant body is interwoven mass of white

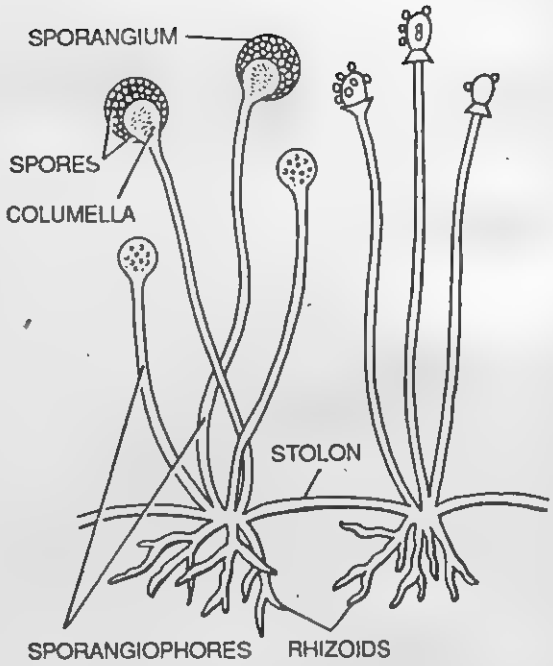


Fig. 13·6 : Rhizopus.

cottony threads, and is known as mycelium

2. Young hyphae are branched, *coenocytic* (multinucleate) and unseptate.

3. Old hyphae are differentiated into 3 parts :

(i) *Stoloniferous hyphae* are unbranched and thicker fibres which grow parallel to surface of food and help in the spread of fungus and are differentiated into *nodes* and *internodes.*

(ii) *Rhizoidal hyphae* are thin, delicate and branched that penetrate into food and absorbs it.

(iii) *Sporangiophores* are erect hyphae that arise in cluster vertically from the node of stolon. Each bears a rounded *sporangium* at its free distal end. Sporangium contains spores.

4. Cell wall is formed of fungus cellulose.

5. Food is stored as glycogen.

6. *Rhizopus* grows on moist bread; prickle, leather goods and cooked vegetables mostly in rainy season.

6. MUCOUR

Classification

Same as in *Rhizopus*.

Comments

It is similar to that of Rhizopus except that —

1. stolon nodes, internodes, rhizodal hyphae are absent.

2. Some hyphae from the mycelium penetrate the substratum and help in anchorage and absorption. These hyphae are known as absorptive hyphae.

3. The sporangiophores arise singly and not in groups as in Rhizopus.

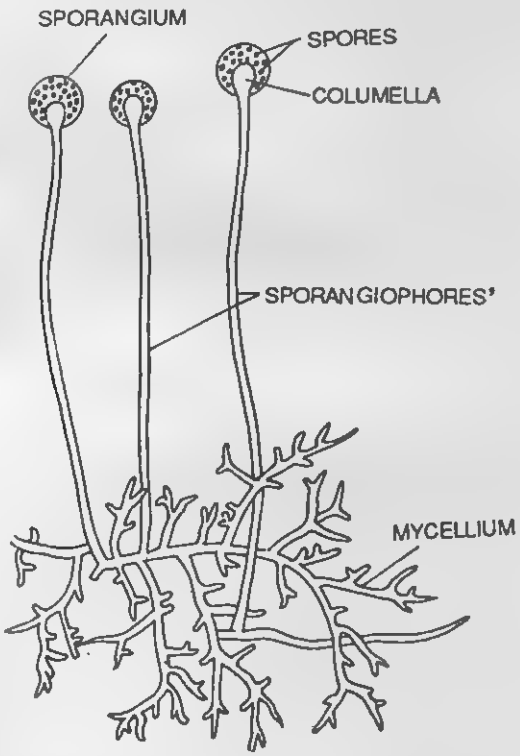


Fig. 13-7 : Mucor—Mycelium and Sporangia.

Identification

Mucor :

(i) Stolons absent

(ii) Sporangiophores arise singly.

7. MUSHROOM
(*Agaricus*)

Classification

Kingdom — *Mycota* or *Fungi*
Division — *Eumycota*
Subdivision — *Basidiomycotina*
Class — *Hymenomycetes* (Basidia and paraphyses arranged in a palisade like manner forming hymenium).
Order — *Agaricales* (Basidiocarp fleshy and present above the ground)

Type — *Agaricus edible.*

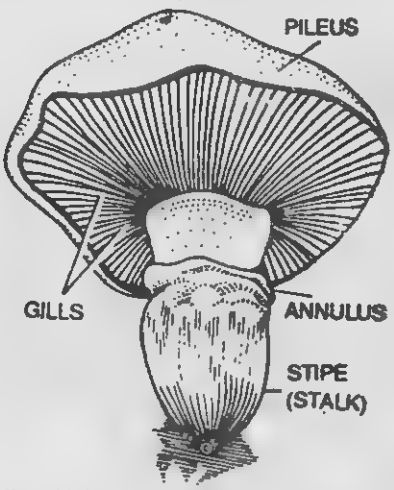


Fig. 13-8 : Agaricus (edible mushroom)

Comments

1. Mushrooms grows on dead and decaying organic substances specially humus soil, rotten logs, tree trunks etc. during rainy season.

Differences between Rhizopus and Mucour

Rhizopus	Mucour
1. Hyphae are light brown or dark brown in colour.	1. Hyphae are white or colourless.
2. Hyphae are not much branched.	2. Hyphae highly branched.
3. Rhizoidal and stoloniferous hyphae are distinct.	3. Rhizoidal hyphae and stoloniferous not differentiated.
4. Hyphae thicker.	4. Hyphae are thick.

2. Saprophytic in nature.

3. *Mycelium* subterranean and forms a tangled mass of interwoven hyphae.

4. Form fruiting bodies — *basidiocarps*

5. A *basidiocarp* grows vertically above the ground and has following parts:

(i) stalk-like - *stipe*

(ii) terminal cap-like - *pilus.*

6. *Pilus* is circular and umbrella-like and has a number of vertical plate-like structures along its under surface. These are called *gills* or lamellae and bear *basidia* and *basidiospores.*

Stipe is formed of fungal hyphae.

7. Some varieties are used as food but some mushrooms are poisonous.

8. YEAST

Kingdom	— *Mycota*
Division	— *Eumycota*
Subdivision	— *Ascomycotina* (Mycelium septate, ascus and ascospores are formed)
Class	— *Hemiascomycetes* (Asci naked; ascocarp and ascogenous hyphae not formed)
Order	— *Endomycetales* (Unicellular, multiply by budding and fission)
Type	— *Saccharomyces* (budding and fission common, breaks carbohydrates into CO_2 and alcohal)

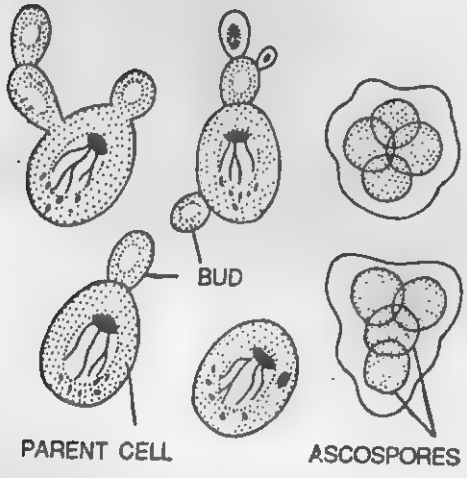


Fig. 13. 9 : Yeast Cells Showing Budding and Ascospores.

Comments

1. It is a unicellular, microscopic fungus, which rarely forms a *pseudomycelium* (at the time of budding).

2. Cells may be rounded, elliptical or oval etc.

3. Cell wall is made up of *chitin* and other compounds but not of cellulose.

4. Several small dark bodies are present in the peripheral region of cytoplasm, known as *mitochondria.*

5. Each cell is uninucleate and the nucleus has a definite nuclear membrane.

6. A distinct hyaline central vacuole.

7. Volutin granules and glycogen are stored food in the cytoplasm.

9. RICCIA
(Liverwort)

Classification

Division	— *Bryohyta* (Amphibious plants; Plant body gametophytics and thalloid, vascular or conducting tissue absent)
Class	— *Hepaticosida* (Scales and rhizoids present assimilatory cells with chloroplasts)
Order	— *Marchantiales* (Thallus flattened and dichotomously branched)
Type	— *Riccia* (Liverwort) (Plant body forms rosette, sporophyte spherical and represented by capsule only)

Comments

1. Amphibious plants that grow on moist land.

2. Body forms a *rosette* due to repeated dichotomous branching of thallus.

3. Body thalloid, prostate, dorsoventrally flattened and dichotomously branched.

4. Each thallus lobe has an *apical notch* with growing point.

5. Dorsal surface of thallus is smooth one has a conspicuous median longitudinal groove.

6. Scales and rhizoids present on the ventral surface. Scales protect the growing apex and retain moisture.

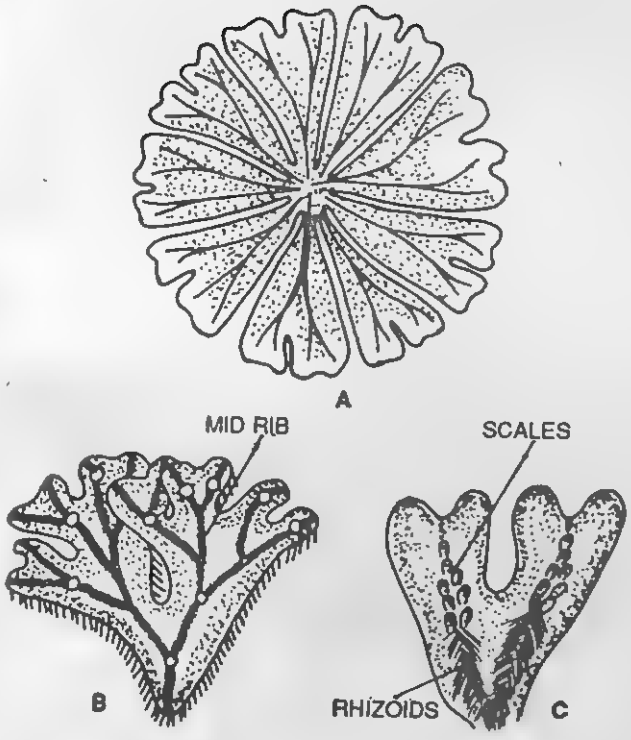


Fig. 13.10 : Riccia

7. *Rhizoids* are unicellular, colourless and tubular and help in anchoring and absorption.

8. Thallus represents haploid gametophytic stage. It bears sex organs (*anthridia*-male sex organs and *archegonia*-female sex-organs).

9. *Sporophyte* is just a *capsule*, embedded in the thallus (gametophyte)

10. Sporophyte produces tetrad of *spores* by reduction divion.

11. Spores are haploid and germinate into gametophyte or thallus.

12. Life cycle *exhibits alternation of generations.*

10. MARCHANTIA
(Liverwort)

Classification

Same as in Riccia.

Comments

1. Amphibious plants. These grow on moist land.

2. Plant body thalloid, prostrate, dorsoventrally flattened and dichotomously branched.

3. Apex of each thallus lobe is notched.

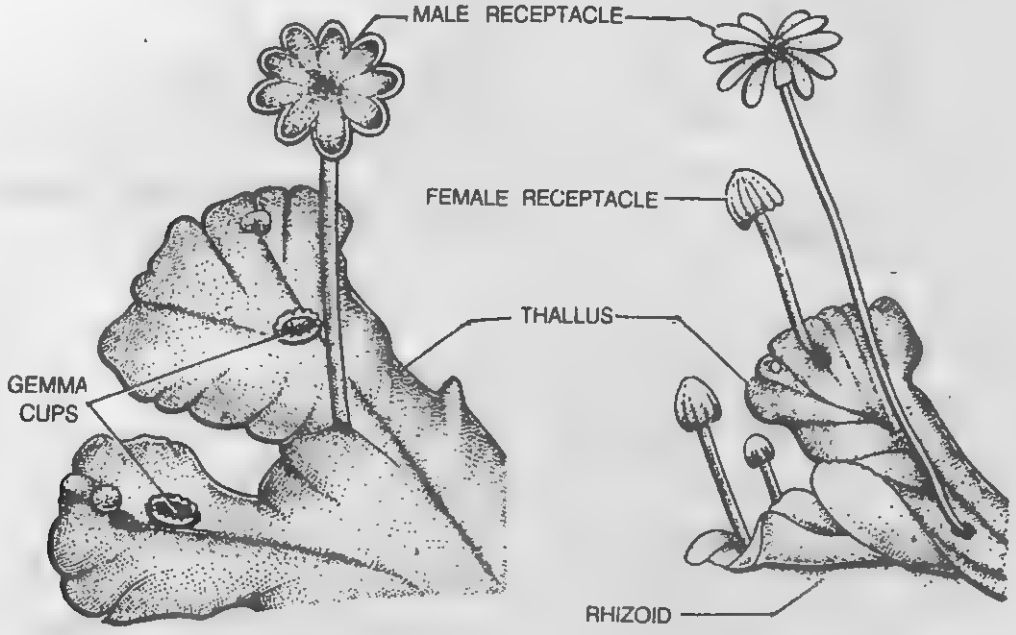


Fig. 13.11 : Marchantia

4. A median longitudinal groove on the dorsal surface and a corresponding ridge on the ventral side.

5. Dorsal surface is marked into rhomboidal areas corresponding to air chambers, each with a *air pore* in the centre.

6. *Gemma cups* are sub-sessile cup-shaped bodies and help in vegetative multiplication.

7. Multicellular purple coloured *scales* and unicellular *rhizoids* present on the ventral surface.

8. *Scales* protect the growing apex and help in retaining moisture.

9. *Rhizoids* help in anchorage.

10. *Archigonia* and *anthridia* are present on special erect branches called *archigoniophores* and *anthridiophores* respectively.

11. FUNARIA
(Moss)

Classification

Division —*Bryophyta* (Plant body gametophytic and thylloid, vascular tissue absent, sporophyte dependent on gametophyte)

Class —*Musci or Bryopsida* (Rhizoids branched and multicellular and with oblique septa)

Order —*Funariales* (Leaves sessile with acute apex and broad base; peristomial teeth present in two rows).

Type — *Funaria* (Leaves spirally arranged, stem differentiated into epidermis, cortex and medulla)

Comments

1. The plant body is gemetophyte. It is green, erect and is distrinctly differentiated into rhizoids, main axis (stem) and leaves.

2. Rhizoids multicellular and branched with oblique septa. They help in absorption and anchoring the plant with the substratum.

3. Main axis is erect slender and covered by leaves.

4. The leaves are spirally arranged on the stem.

5. Each leaf is simple, subsessile with a broad sheathing base and acute apex.

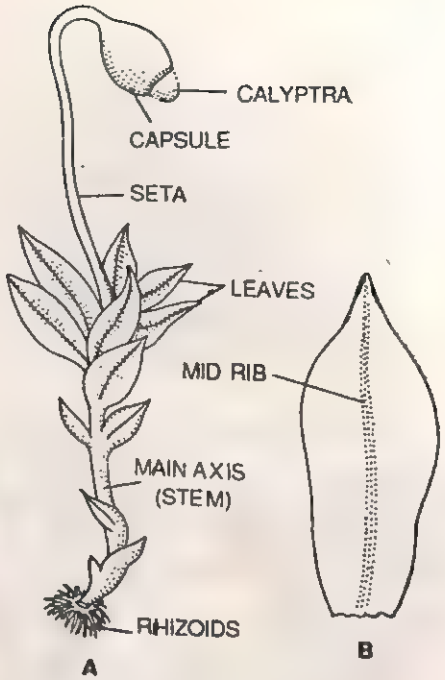


Fig. 13.12 : Funaria—(A) Mature plant with sporophyte (B) Single leaf.

6. Antheridia grow in groups at the apex of male branch and archegonia at the apex of female branch.

7. Sporophyte partially dependent on gametophyte and is differentiated into foot, seta and capsule.

8. Capsule encloses spore sac containing spores.

9. Spore grows out into protonema, that gives rise to gametophyte.

10. Exhibits alternation of asexual and sexual or haploid and diploid generations.

12. DRYOPTERIS
(Fern)

Classification

Division —*Pteridophyta* (Primitive seed-less vascular plants)

Class —*Felicinae*

Type —*Dryopteris*

Comments

1. Ferns are highly developed pteridophytes.

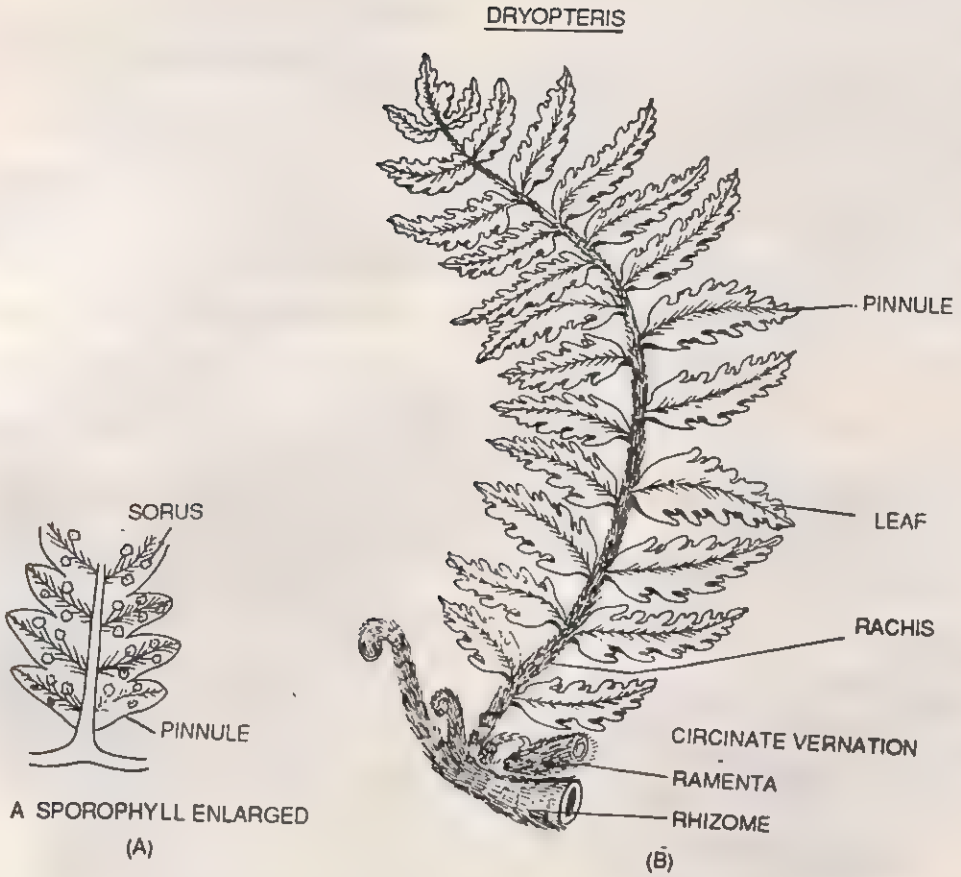


Fig. 13.13 : Fern.

2. These are perennial land plants growing in cool, shady and moist places.

3. Plant body is *diploid* and *sporophyte.*

4. It is divided into *stem, root* and *leaves.*

5. Stem is *rhizome* and is covered by persistent bases of dead leaves.

6. Cluster of *leaves* are given out in the air. These form the main visible part of plant body.

7. *Roots* are adventitious.

8. *Leaves* are petiolate and pinnately compound. Leaflets or *pinnae* are arranged in two lateral rows on the rachis.

9. Younger parts of rhizome, petiole and lamina are covered with hair-like processes, *ramenta.*

10. Young leaves have *circinate ptyxis.*

11. *Sori* are present is two rows along the margin of pinnules. These produce spores.

12. *Spores* are haploid and grow into gametophyte called *prothallus.*

13. *Prothallus* is heart-shaped and monoecious bearing both antheridia and archegonia.

14. Sporophyte starts growing on the prothallus.

15. Life cycle shows *alternation of generations*—diploid sporophyte alternating with haploid gametophyte.

13. PINUS
(Pine)

Classification

Phylum	— *Spermatophyta* or *Phanerogams* (seed bearing plants)
Division	— *Gymnosperms* (Plant sporophytes; ovules naked; reproductive organs arranged in cones, true fruits are not formed)
Class	— *Coniferopsida* (wood pycnoxylic; branches dimorphic)
Order	— *Coniferales* (conifers ; xerophytic, woody and evergreen trees ; foliage leaves needle - like)

CONIFERS

Fig. 13-14 : Pinus tree.

Comments

1. Grows in subtropical region on the slopes of lofty mountains.

2. Plant body is sporophyte, tall green tree.

3. Trees are tall, graceful and everygreen ; source of timber, resin and paper pulp.

4. Root shows *tap-root system*, Roots covered by *fungal hyphae* that form *ectotrophic mycorrhiza*.

5. Stem covered with scaly bark and bears two types of branches — (i) *Long shoots* with apical bud and growing indefinitely.

(ii) *Short shoots* without apical bud and with limited growth.

6. Leaves dimorphic—

(i) *Scaly leaves* are brown, thin structures.

(ii) *Foliage leaves* are long, acicular, green and *needle-like* and borne on dwarf shoots only.

7. Dwarf shoot with foliage leaves is called *spur*.

8. Pinus trees are *monoecious*. The *male* and *female cones* bearing *microsporophylls* and *megasporophylls* are borne on different branches.

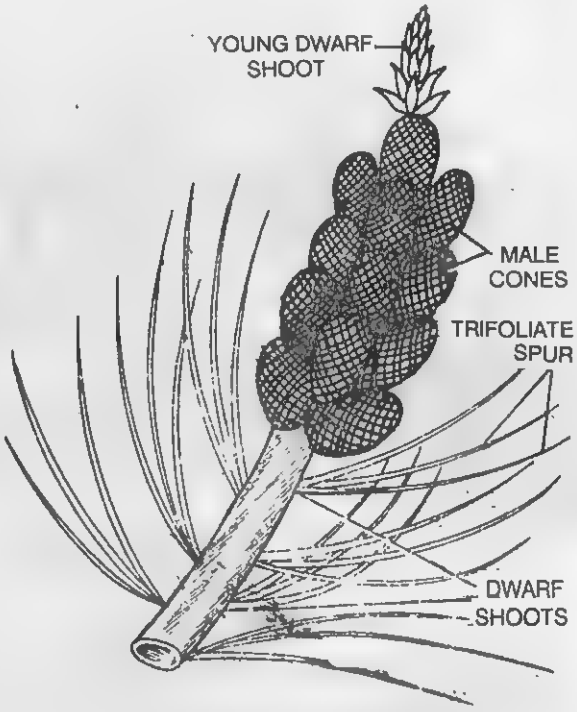


Fig. 13-15 : A part of branch of Pinus bearing male cones.

9. *Male cones* are ovoid, brown in colour and narrow at the base and broad at the apex. The *microsporophylls* are small membranous and scaly and more compactly arranged.

10. *Female cones* are large, elongated, cylindrical and woody; brown in colour; broad at the base and narrow at the apex. The *megasporophylls* are large, woody, triangular and loosely arranged.

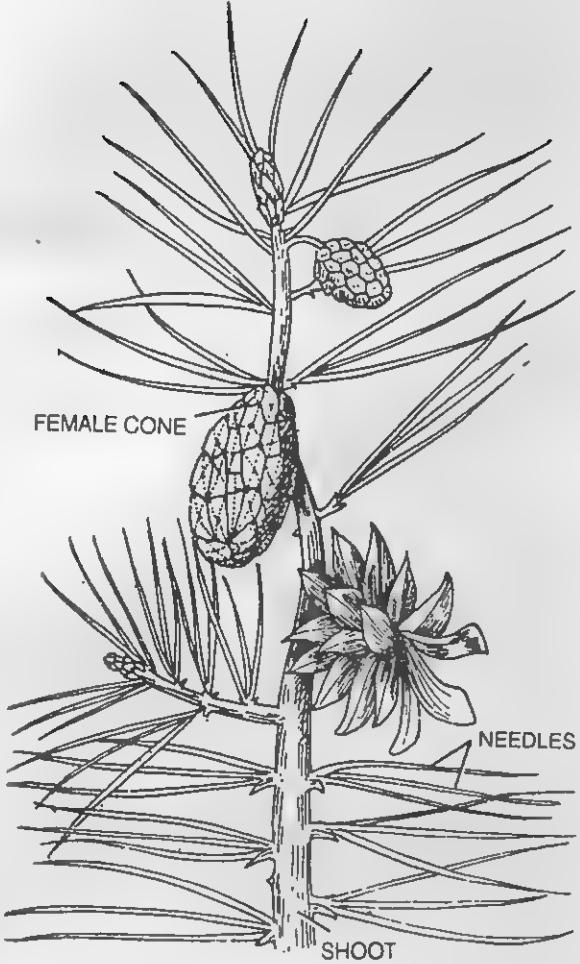


Fig. 13.16 : Part of a branch of Pinus bearing female cone.

11. Seeds are oval and winged.

14. BIOTA
(Thuja)

Classification

Phylum — *Spermatophyta*
Division — *Gymnosperms*
Class — *Coniferopsida*
Order — *Coniferales*

Comments

1. Thuja is a small conifer, native of China and Japan. Now it is cultivated as an ornamental plant in gardens.

2. Plant is a small tree of conical or pyramidal shape. It is evergreen, perennial and bushy.

3. Differentiated into root, stem and leaves.

4. *Stem* is covered by a thin reddish brown bark.

5. *Branches* are erect, vertical and with oblique secondary branches.

6. Leaves are small, scale like and green; arranged in four rows of two opposite sets, overlapping each other.

7. *Biota is monoecious*, male and female cones are born on same plant but on different branches.

8. *Male cones* are inconspicuous and small, have 5-6 pairs of microsporophylls.

9. *Female cones* are more conspicuous, small and globular or ovoid, having 3-10 pairs of cone-scales or macrosporophylls.

10. Cones scales are fleshy, green and with recurved apex forming a hook-like structure, called *boss*.

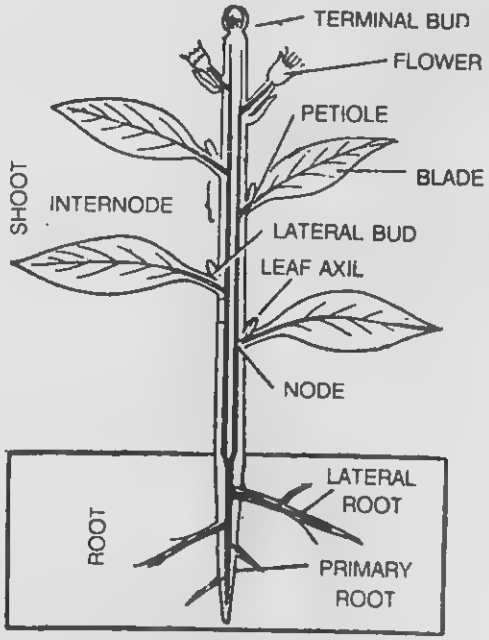


Fig. 13-17 : Thuja.

15. BRASSICA COMPESTRIS
(Mustard —A dicot plant)

Classification

Kingdom — *Spermatophyta* (seed bearing plants)
Division — *Angiosperms* (ovules are enclosed in the ovary; plants bear flowers)

—*Dicotyledonae* (seeds with two cotyledons)

Familiae —Cruciferae.

Comments

Dicot plants have following characteristic feature —

1. Dicot plants may be herbs, shrubs or trees.

2. *Root* is tap root.

3. *Stem* of dicot plants usually have bark and continue to grow in girth throughout life.

4. Leaves are dorsiventral and have netted veins. Usually these have alternate arrangement.

5. Floral parts in dicotyledonous plants are usually arranged in five or in multiple of five or their number may vary.

6. *Seeds* have two cotyledons.

7. *Secondary growth* occurs in the root and stem of dicotyledonous plants.

8. *Vascular bundles* are of open type.

16. A MONOCOT PLANT

Comments

Monocot plants have following characteristic features—

Fig. 13-18 : A monocot plant. —Maize

1. Monocot plants are herbs and grasses. These include bamboos, sugar canes, all grasses, sedges and all cereals (corn, rice, wheat, etc.), banana etc.

2. *Root* forms *adventitious system.*

3. *Stem* is without bark. It reaches only a certain diameter, does not grow in girth throughout life.

4. *Leaves* are large *isobilateral* and with parallel venation. Usually leaves are arranged opposite or in whorls.

5. *Floral parts* are usually arranged in threes or in multiples of three.

6. Seeds are with a single cotyledon but with an endosperm.

7. *Secondary growth is absent.*

8. *Vascular bundles* are closed type without cambium.

17. LICHEN

Comments

1. Lichens are formed by the symbiotic association of algae and fungi.

2. An alga and a fungus grow in close contact forming *consortium* and appear as a single plant.

3. Thallus of lichen is irregularly lobed, flat or cylindrical. It resembles neither alga nor fungus.

4. Algal individuals are called phycobiont and belong to Chlorophyceae and Myxophyceae.

5. Fungal individuals belong to Ascomycetes or Basidiomycetes.

6. Lichens grow on bare rocks, stones, tree twigs and are distributed all over the globes.

In *foliose lichen*, Thallus is flat and lobed and resembles a dry forked leaf. It is attached with the substratum (tree twing) by rhizoid-like *rhizines*, developing from under surface of thallus.

Fruiting bodies are present on its upper surface; are cup-like (apothecial type) and fungal in nature.

Apothecia contain *asci* and *ascospores*. Lichens can grow even in Tundra where no other vegetation can grow.

Fig. 13·19 : A foliose lichen growing on tree trunk.

18. ROOT NODULES OF A LEGUMINOUS PLANT
(Symbiosis)

Comments

1. These are roots of a leguminous plant having root *nodules.*

2. *Root nodules* harbour nitrifying bacteria *(Bacillus radicicola or Pseudomonas radicicola)*

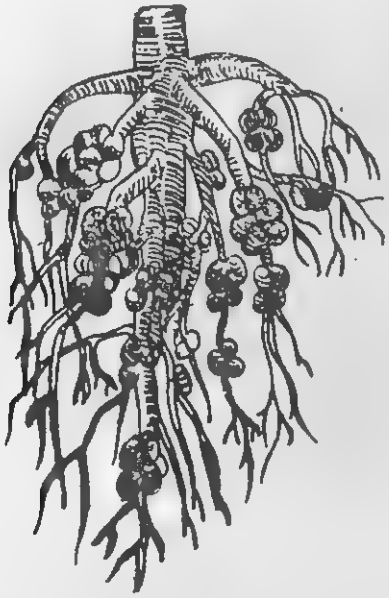


Fig. 13·20 : Root nodules of legumes.

3. Nodule cells are full of bacteria.

4. These bacteria fix atmospheric nitrogen and supply it to the host plant in the form of amino compounds.

5. These enrich soil with nitrogen compounds and make it more fertile.

6. Leguminous plants and bacteria show *symbiosis* because :

(i) Bacteria supply nitrogen to leguminous plants.

(ii) Plants in return, provide organic nutrients to bacteria.

19. CUSCUTA
(Amar bale-Doddar)
(A total parasite)

Classification

Kingdom — *Plantae*
Phylum — *Tracheophyta*
Class — *Angiospermae*

Comments

1. It is a *total stem parasite.*

2. Plant is in the form of a yellow coloured twining wiry stem.

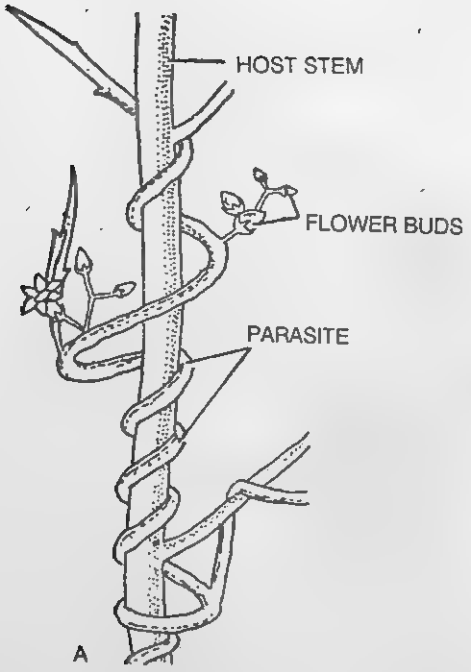


Fig. 13·21 : Cuscuta reflexa (A) Parasite twining the host (b) T.S. host plant showing roots of parasite.

3. It has no leaves.

4. *Haustorial discs* fix the parasite on the host's stem.

5. *Haustoria* (parasitic roots) penetrate the conducting vessels (xylem and phloem) and pith of the host stem to collect food and water.

20. UTRICULARIA (Bladderwort)
(An Insectivorous Plant)

Comments

1. It is an insectivorous plant; commonly known as '*bladderwort*'.

2. It grows in ponds, ditches and marshes.

3. Leaves are finely dissected and submerged. These resemble green roots.

4. Minute *bladders* or *utricles* are modified segments of leaves.

5. Opening of bladder has a *valve*. The valve can be pushed in but cannot be pushed out.

6. The valved door and opening have long branched hairs or *bristles*.

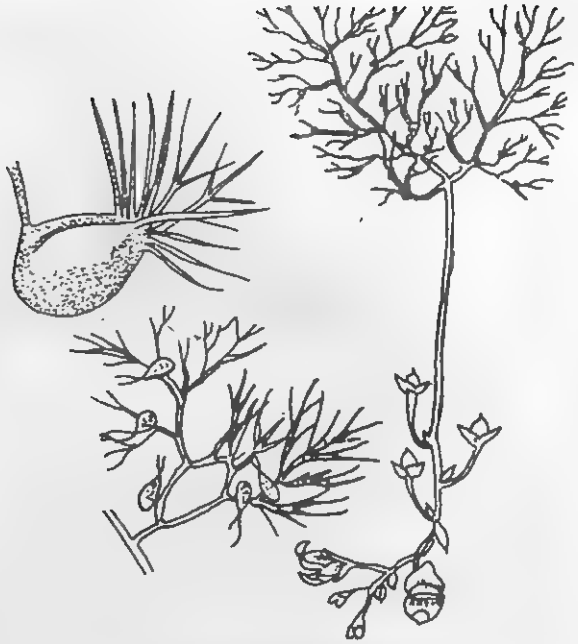


Fig. 13.22 : Utricularia (Bladderwort) A—A part of plant B—twig with bladders C—A bladde enlarged.

7. Inner wall of bladder has *digestive glands* and *water absorbing hair*.

8. The water organism when push bristles, the valve door opens and some water with organisms is sucked in.

21. DROSERA (Sundew)
(Insectivorous plant)

Fig. 13·23 : Drosera, A - An entire plant, B - Leaf-lamina with tentacles.

Classification

Same as in Cuscuta.

Comments

1. *Drosera* is an insectivorous plant, commonly known as 'sundew'.

2. These are found in Eastern India, Western Himalayas and Ghats.

3. The plant has a rosettes of radical leaves

4. The upper surface of leaf-lamina is covered with glandular *tentacles.*

5. Tip of tentacles bear *glands* which secrete a sticky fluid.

6. The drop of fluid shines in sun like *dew drop* and attracts insects.

7. Insects get entangled in the sticky fluid and tentacles bend to trap the insects.

8. The digestive enzymes secreted by the glands digest protein and absorbed by leaf surface.

9. Tentacles are *chemoreceptors*, sensitive to protein.

22. HYDRILLA AND ELODEA

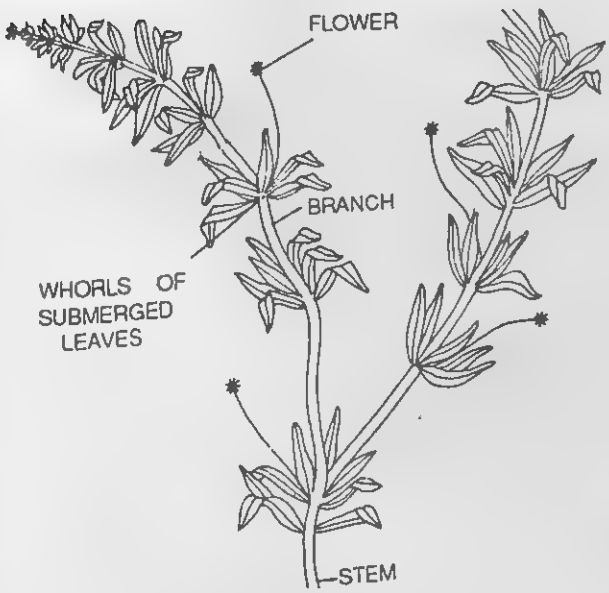


Fig. 13·24 A—A part of Hydrilla plant

Comments

1. It is an attached submerged type of *aquatic plant.*

2. It is attached with the mud (substratum) by means of well developed roots.

3. Branches are developed in upright direction *i.e.*, vertical in position and are long, weak and have nodes and internodes.

4. Leaves are small, membranous, green in colour and lanceolate in shape.

5. Leaves form whorl on nodes.

B —An Elodea plant.

23. OPUNTIA
(Phylloclade)

Comments

1. This is a common perennial **xerophytic plant** *Opuntia*.

2. It is an aerial modification of stem into flat green, sacculent structure.

3. It performs the function of leaves.

4. Leaves are reduced to spines to avoid transpiration.

5. It is known as *phylloclade* which consists of many internodes which have become flattened.

6. This plant shows xerophytic adaptation.

7. It is **malcophyllous type** of xerophyte because of fleshy and sacculent stem which contains mucilage also.

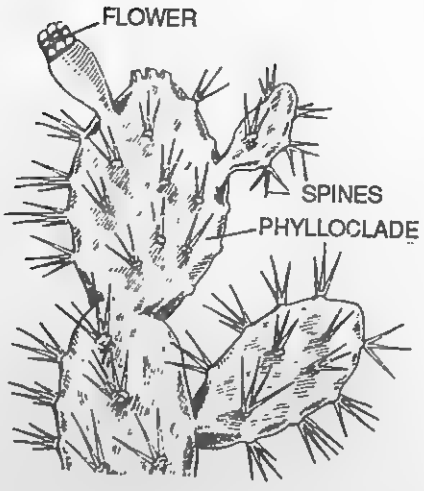


Fig. 13·25 : Phylloclade of Opuntia.

24. EUPHORBIA SPLENDENS

Comments

1. It is a twig of *Euphorbia splendens*, a common ornamental plant, a member of family *Euphorbiaceae*.

2. It is microphyllous types of xerophyte.

3. *Stipules* are modified into spines.

4. *Leaves* are caducous in nature.

5. The stem is hard and filled with mucilage.

6. Red coloured cyathium inflorescene is seen in the specimen.

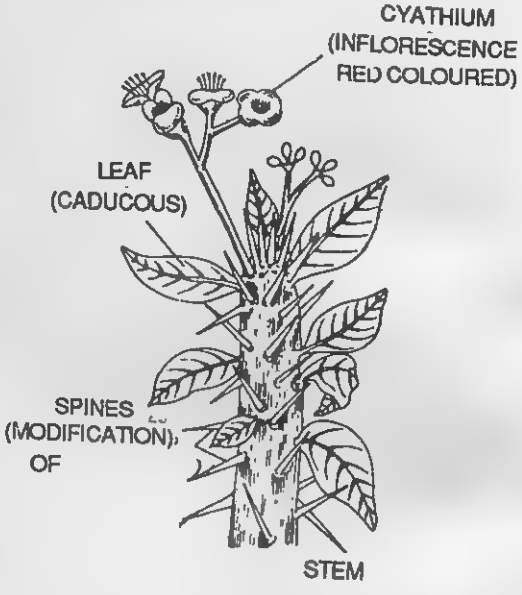


Fig. 13·26 : Euphorbia

ORAL QUESTIONS

Q. 1. *What is that branch of botany under which you study fungi ?*

Ans . Mycology.

Q. 2. *Under scheme of classification algae and fungi are what type of plants ?*

Ans . Thallophytes.

Q. 3. *How many types of nutritions are found in fungi ?*

Ans . 1. Saprophytic nutrition 2. Parasitic nutrition.

Q. 4. *Which group of plants does not do photosynthesis ?*

Ans . Fungi.

Q. 5. *What is mode of nutrition of Rhizopus?*

Ans . Saprophytic

Q. 6. *What is the difference between Rhizopus and Mucor.*

Ans . Mycelium or Rhizopus is formed or aseptate and unbranched hyphae, while that of Mucour is formed of septate and branched hyphae.

Q. 7. *What is yeast ?*

Ans . Yeast is a unicellular saprophytic fungus.

Q. 8. *How sugar solution is converted into alcohal by yeast cells ?*

Ans . By fermentation of sugar solution.

Q. 9. *What are two basic characters of fungi ?*

Ans . 1. Lack chlorophyll, therefore these are nongreen and nonphotosynthetic.

2. Either saprophytic or parasitic in nature.

3. Produce resistant reproductive bodies called *spores.*

Q. 10. *Why algae are called Thallophytes ?*

Ans . In Algae plant body is not differentiated into root, stem and leaves.

Q. 11. *What is study of algae called ?*

Ans . Phycology.

Q. 12. *Where do you find spirogyra and ulothrix ?*

Ans . In freshwater ponds.

Q. 13. *What are basic differences in spirogyra and ulothrix ?*

Ans . 1. All the cells of a filament are similar in Spirogyra; In Ulothrix the apical cell and basal cell are different from rest of the cells of a filament.

2. Cells of Spirogyra are longer than broad; cells of Ulothrix are broader than long.

3. A large vacuole, a number of ribbon-like chloroplasts are present in Spirogyra, Each cell of Ulothrix has only one C-shaped chloroplast and has no vacuole.

Q. 14. *What is alternation of generation ?*

Ans . Alternation of diploid asexual or sporophytic generation with haploid sexual gametophytic generation is called alternation of generations.

Q. 15. *Is Funaria plant a sporophyte or Gametophyte ?*

Ans . Gametophyte.

Q. 16. *In Bryophytes which generation predominates gametophytic or sporophytic ?*

Ans . Gametophytic generation.

Q. 17. *Name the gemetophyte of fern.*

Ans . Prothallus.

Q. 18. *What is conjugation ? In which group of plants it is found ?*

Ans . Conjugation is a sexual mode of reproduction. It is found in *Spirogyra* and in bacteria.

Q. 19. *What is the name of male and female reproductive organs in bryophytes ?*

Ans. Male reproductive organs are called antheridia and female reproductive organs are called archegonia.

Q. 20. *What is the nature of stem in ferns ?*

Ans. It is rhizome and the green part represent leaves.

Q. 21. *What is the nature of leaves in a fern ?*

Ans. Fern leaves are bipinnately compound with cercinate venation.

Q. 22. *How many types of roots are found in Cycas plants ?*

Ans . Two types of roots —1. Normal roots, 2. Coralloid roots.

Q. 23. *What are coralloid roots ?*

Ans. Coralloid roots of *Cycas* come to the earth surface and are occupied by blue green algae.

Q. 24. *Why Gymnosperms are called naked seed plants ?*

Ans. Gymnosperms do not bear flowers and do not form fruits. The reproductive organs are naked borne on cones. The seeds are naked, not enclosed in the fruit.

Q. 25. *What is the difference between Gymnosperms and Angiosperms ?*

Ans . In Gymnosperms seeds are naked, male and female reproductive organs are borne separately on cones, flowers and fruits are not formed. In Angiosperms seeds are enclosed in fruits. Flowers are formed. Sepals and petals protect the reproductive organs.

Q. 26. *Give differences between a monocot and a dicot leaf ?*

Ans . Monocot leaf is isobilateral and has parallel venation. A dicot leaf is dorsiventral and has reticulate venation.

Q. 27. *Can you identify whether a flower belongs to a monocot plant or a dicot plant?*

Ans. Yes. Flower of a monocot plant is trimerous, each of its whorls (sepals, petals, anthers etc). are formed of 3 or six pieces. Flower of dicot plants are either tetramerous or pentamerous.

Q. 28. *Define parasitism.*

Ans . A parasite totally depends on some other living system for its food and causes harm to the host.

□ □

CORE EXPERIMENT 14

DETERMINATION OF POPULATION DENSITY OF PLANTS BY QUADRATE METHOD

Aim : To determine population density of plants by quadrate method.

Material Required

Digger	Quadrate of required sizes (wooden square frame)
Tape	Crayons or coloured pencils
Nails	Scale, string
Notebook	

Theory

Population : Population may be defined as relatively a permanent aggregation of individuals of a species at a definite area or space in a natural habitat at a given time.

This habitat may be large (like forest, desert) or small (vegetation in a pond, on a rock or restricted area). Population studies are done in terms of frequency, density and abundance.

Population density : Population density of a species in a given area is defined as the number of individuals per unit area. It is determined by counting individuals of the species and dividing it by the number of units of space.

$$\text{Population density} = \frac{\text{Total no. of individuals}}{\text{Number of units of space}}$$

$$\text{i.e. } D = \frac{N}{S}$$

Frequency - It can be defined as the degree of dispersal of a species expressed in terms of percentage.

Abundance : It is defined as the number of individuals per unit quadrate of occurrence.

Sampling Technique

Sampling unit is that small area of plant community in which structure and functions are studied. The area of sampling unit is based on the life forms of plant community. This unit is usually 100 square meter (10 × 10 metre) area in forest community, 1 square meter (100 × 100 cm.) in grasslands.

For plant ecological studies mainly following three types of sampling units are used -

(i) Quadrate.
(ii) Transect.
(iii) Point.

1. Quadrate

Different types of quadrates have been shown in Fig. 14.1 The shape of quadrate is usually square but it may be of different shapes (rectangular, circular, etc.) depending upon the convenience and usefulness. The size of quadrate varies with the type of vegetation to be studied. For small size plants likes mosses, lichens etc. small quadrates of 20 × 20 cm. size may be quite useful while for grasslands 50 × 50 cm. or 1 metre × 1 metre may be needed. In forests the quadrates may be quite large, 10 × 10 metres or even more bigger. For successional study permanent quardrates are used so that morphological variations may be seen in plant community as influenced by time and environment.

2. Transect

In this method the study of plant population is performed in a straight line or in long belts. This method is usually used for study of vegetation of hilly areas and forests. It may be of two types:-

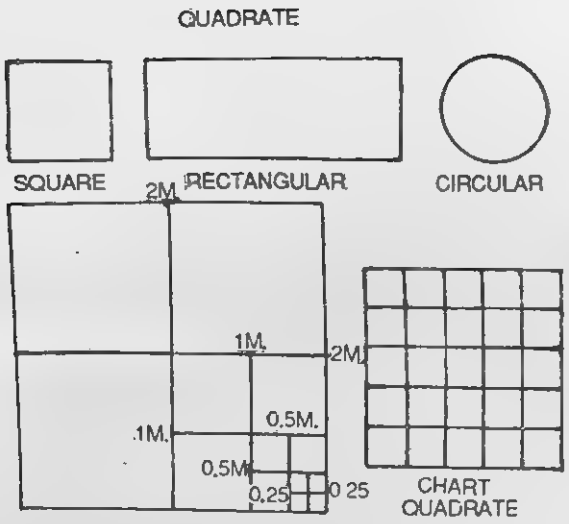


Fig. 14·1 : Quadrates.

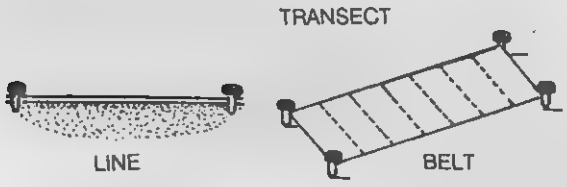


Fig. 14·2 : Transects.

(A) Line transect - By this methods plants in a straight line are studied.

(B) Belt transect - In this sampling unit there is a long belt 10 cm. to 50 cm. wide and we study the palnts occuring in it.

The length of line and belt transect may be from 1 metre to 100 metres.

3. Point Frame Method

Point frame apparatus also functions on point method principle. This apparatus has a 50 cm. long wooden frame which is mounted on a pair of legs and remain nearly 50 cm. above and parallel to the earth. Horizontally placed wooden frame has 10 holes equidistantly and each hole has a bar or nail.

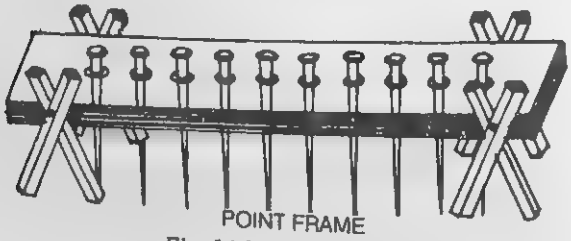


Fig. 14·3 : Point Frame.

A. Soil Temperature - With the help of soil thermometer measure the temperature of the soil. Temperature of the atmosphere should also be measured at the same time so that the two could be compared, if required.

B. Soil Colour - This is an index of fertility which is mainly due to the presence of minerals and organic matter.

C. Soil Texture - With the help of a hand lens and by feeling the soil between two fingers both wet and dry samples try to judge as given in the key below:-

Sand - Soil is loose and coarse.

Sandy loam - When pressed between thumb and finger, it will form a cast which will readily disappear.

Loam - Loam is a mixture of sand, silt and smooth clay. When pressed it forms a cast which remains there for sometime.

Clay loam - A clay is a fine textured soil which breaks into hard lumps when dry.

Clay - This is a fine textured soil that forms very hard lumps when dry. This gives a sticky feeling when wet soil is felt between the thumb and finger.

Soil pH - Soil pH is the relative chemical property of the soil which is measured by the amount of absorbed hydrogen and absorbed metallic cations. When H-ions predominate then the reaction becomes acidic, in the other case the reaction is alkaline. Soil pH is correlated with the amount of calcium and magnesium, solubility of iron, aluminium, manganese and phosphorous, and activity of micro organisms.

Soil pH is measured in the laboratory by using the universal indicator.

In the laboratory, take a tea spoonful of the soil sample in the test tube and mix it with an equal amount of barium sulphate and 20 ml of distilled water. Allow to stand. Place a few drops of the

clear supernatant liquid on a porcelain tile and add an equal amount of the universal indicator. Match the colour of solution with the colour chart for different pH provided on the indicator bottle and read the pH value of the soil sample.

Studying the Plants

With the help of quadrates the selected area can be considered for counting the diverse types of plants such as herbs, grasses, shrubs etc. if found in that locality. Lower the quadrate in a particular place and collect the plant samples (team work) from smaller units of the squares. Most of the plants cannot be identified in the field. Therefore, they are plucked and a labelled tag is tied around them by giving names such as A, B, C & D etc.

The number of plants collected in each square can be counted and represented on a graph and on a note book. Identification of the plants can be done in the laboratory.

Identification of plants. Some of the important plants can be dried and fixed in the herbarium.

Processing of the Data

After identifying plants, the total population of particular species can be calculated which can be further correlated with the frequency and abundance on the different species.

The total population of a particular species in a unit can also be calculated for its frequency.

The total population of a particular species in a unit area can be represented on a graph or histogram. Similarly the different species can be represented on the histogram.

With the help of the histogram and graph paper we can derive the following results:-

1. Name of the species which is least abundant in the population.

2. Name of the species which is most abundant in the population.

3. Environment habit in which the population is most or least abundant.

4. Total number of species of green plants *i.e.* producers.

Illustration

A plan for quadrate in the study of a biotic community in a particular parameter.

Plants can be collected by different teams from the quadrate separately. The plants can be labelled and tagged, which can be identified later in the laboratory.

The percentage and frequency can be calculated by dividing the value in column 4 of the above table (performa) with that in column 5 and multiplying by 100 to obtain percentage frequency of each species

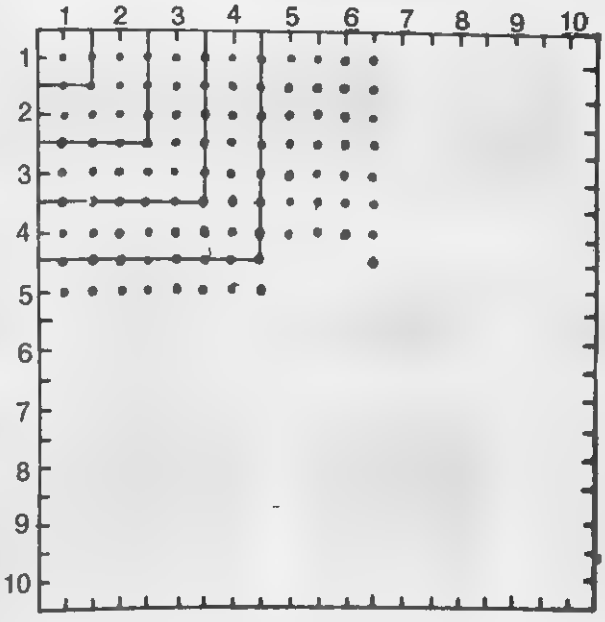


Fig. 14.4 : Histogram.

e.g., $\frac{\text{Total no. of column 4} \times 100}{\text{Total no. of column}}$

= % frequency

Result. From the histogram it would be clear that the species that are dominant are most frequent in the quadrate. These species can grow better in the habitat that is found in this quadrate. Here we

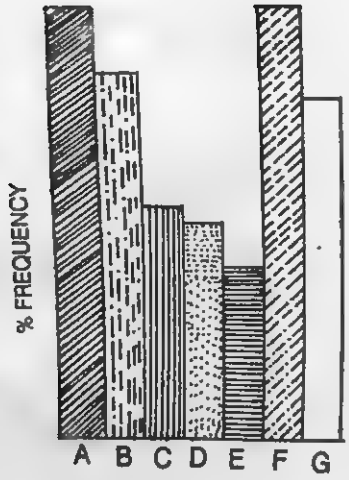


Fig. 14-5 : Histogram.

can describe the names of the boitic community and also (plants and animals) the type of the soil. Similarly, these results can be illustrated on a graph also as follows:

From the graph given above, we can get an idea about the frequency of a species in the quadrate. This can be correlated with the habitat and also interaction with the other species found in the same habitat can be worked out.

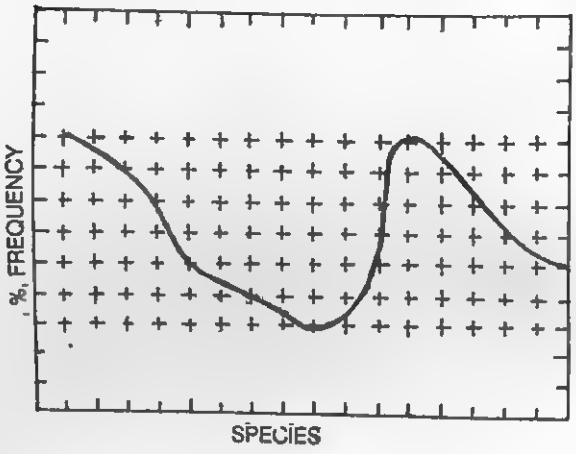


Fig. 14-6 : Graph showing frequency of species.

PROFORMA FOR THE DATE COLLECTED

S. No.	*Habit & the description of its abiotic factors*	*Name of plant*	*Occurrence of Quadrates 1 to 10*	*Total No. of Quadrates Occurrence*	*Total No. of Quadrates Studied*	*Percentage of frequency*
1.	Write the physical characters of soil, besides the feature such as grassland shrub, trees etc.	Write the names of plants or animals after their identification.				
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

N.B.—Give the sign (√) if present and sign (—) if absent in a particular quadrate.

ORAL QUESTIONS

Q. 1. *Define population.*

Ans. It is a group of organisms of the same species occupying a particular area or speace at a given time.

Q. 2. *What do you understand by the term community ?*

Ans. A general term covering any naturally occurring group of different organisms living together in a certain environment and interacting with each other.

Q. 3. *What is population density ?*

Ans. It is the number of individuals of a species per unit area.

Q. 4. *What do you understand by the term ecology ?*

Ans. The study of relationships between the living organisms and the factors of the environment surrounding them is called ecology.

Q. 5. *What do you understand by the term herbarium ?*

Ans. A herbarium is a collection of dried and preserved, plants arranged in a particular order for reference.

□□

CORE EXPERIMENT 15

ECOSYSTEM

STUDY OF TREE / BUSH / POND AS AN ECOSYSTEM

INTRODUCTION

Ecosystem

Ecosytem is a term which expresses the relationships between a biotic community with its abiotic environment. In other words, all living organisms (constituting a biological community) of a particular area which function together is known as ecological system or ecosystem.

Components of Ecosystem

An ecosystem, from structural view-point have four components:

(a) **Abiotic**— basic elements and compounds of the environment (non-living, i.e. water, light, soil, temperature etc.).

(b) **Biotic**

(i) **Producers**—the autotrophic organisms, i.e., green plants.

(ii) **Consumers**—the heterotrophic organisms chiefly animals which produce their own food.

(iii) **Decomposers**—the saprotrophic organisms chiefly the micro-organisms which depend on plants for their food directly or indirectly.

To study various types of ecosystems—pond, grassland, agricultural field, desert, sea shore etc. field trips are to be arranged.

You can arrange a field trip to study the ecosystem which is nearest to you.

Experiment 1. ***To study pond ecosystem.***

Material Required

Museum jars of different sizes, funnels, nets small and big attached to handles of different sizes, formalin, litmus paper or pH paper, herbarium sheets, dissection box, thermometer, glass slides.

A. Observation of Plants

Table 1

S. No.	Name of Plants	Habitat (Land/water)	Description of Habit	Climatic Factors	Other characters observed with the organisms

B. Observation on Animals

S. No.	Name of Animals	Habitat	Habit	Climatic Factors	Other Characters

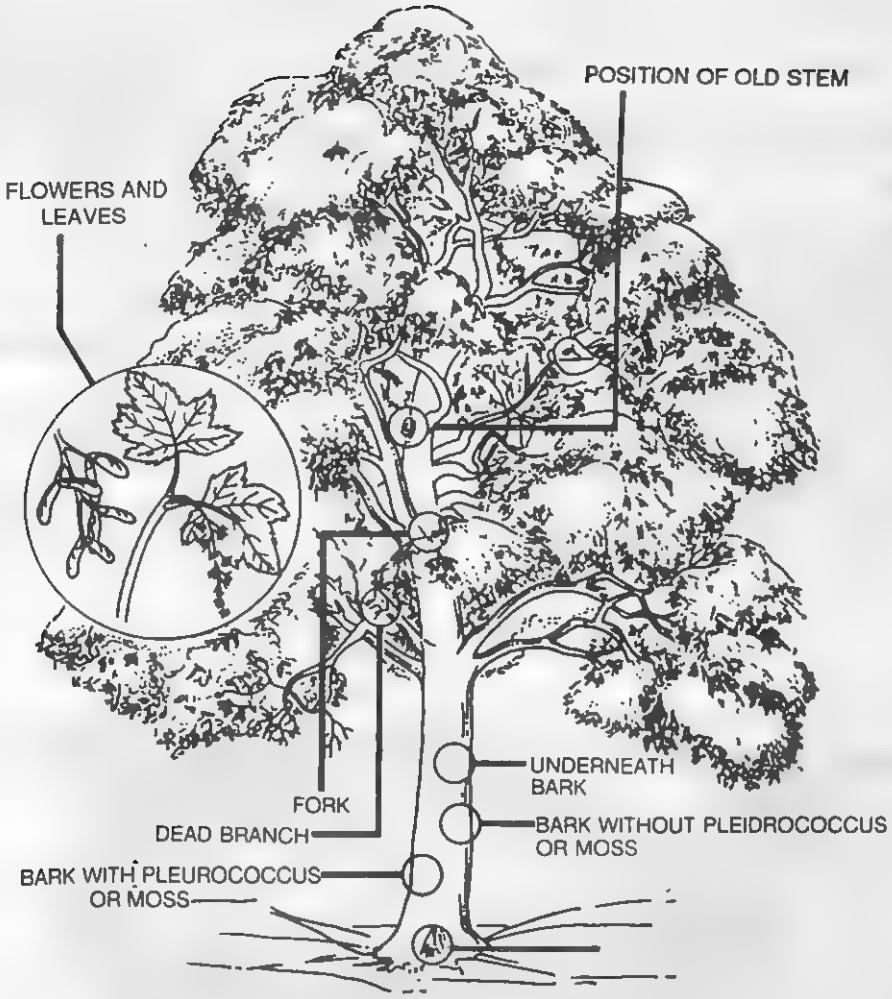


Fig. 15·1 : A tree (an ecosystem).

Procedure

Make a trip to the pond or the ecosystem you want to study. Make a note of the vegetation (plants) growing in and around the pond or lake. Collect sample water from the pond in jar. Collect various plants from different parts of pond. Make a note of the plants and animals in and around the pond in the table given on previous page.

Study table I. Select out organisms as producers, consumers—Primary consumers, Secondary consumers and Decomposers and make a list as given below :

1. Producers - include algae, diatoms.
2. Primary consumers - include small or very small arthropods, worms, some fishes (herbivorous)

Table 2

S. No.	Producers	Primary Consumers	Secondary Consumers	Tertiary Consumers	Decomposers

3. Secondary consumers - include medium sized fishes, frog etc.

4. Tertiary consumers - include large sized fishes.

5. Decomposers - include bacteria and fungi.

II. Abiotic factors

Abiotic factors are water, temperature, soil, light, pressure, depth etc. Study them one by one.

Light : Note the following : Period of light, its intensity, direction, quality, diffused or direct. Also note how light effects the organisms.

Soil : Take a sample of soil from the bottom of pond. Test for its chemical nature. Categorise the soil (clay, loam or sandy). Observe soil particles. Note and draw their appearance.

Temperature : Note the temperature of the soil at four hours interval. Note the minimum and maximum temperature. Compare the atmospheric temperature with that of pond water temperature.

Water : Note the following: Appearance of water, colour, transparency, turbidity, pH, nature (alkaline, acidic, neutral); any other material or factor present in the water.

Pressure : Note the atmospheric pressure and the depth of the pond.

Precautions

1. Do not catch any living animal unless advised to do so.

2. Do not go deep in the pond or lake.

3. Write your own observations.

Experiment 2. ***The study of a tree as an ecosystem.***

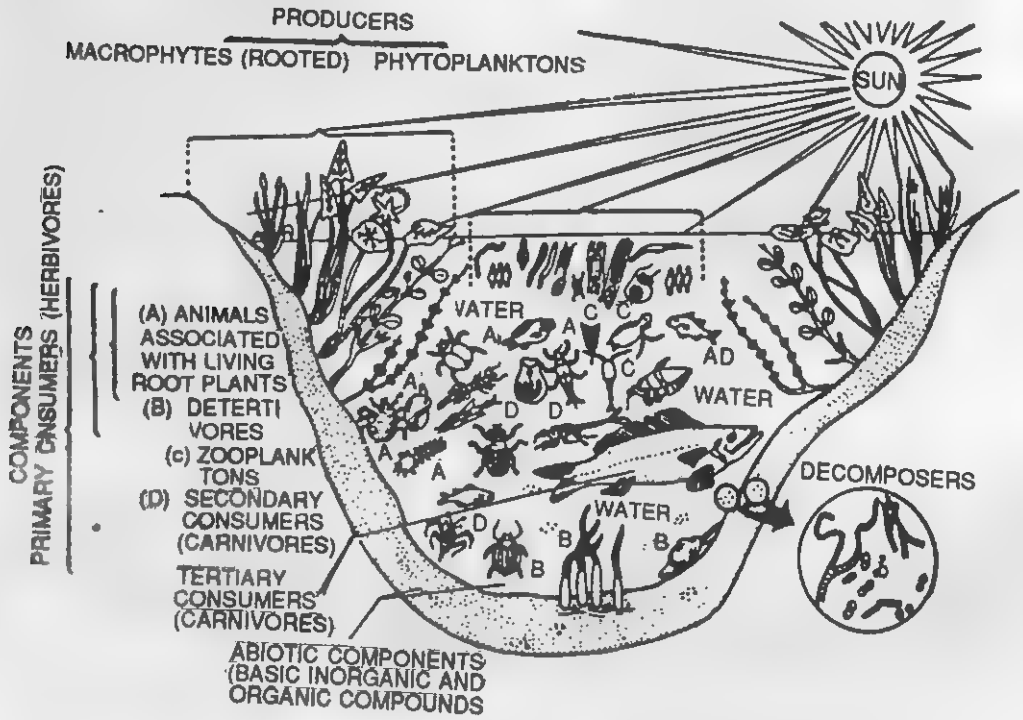


Fig. 15-2 : Study of pond as an example of ecosystem.

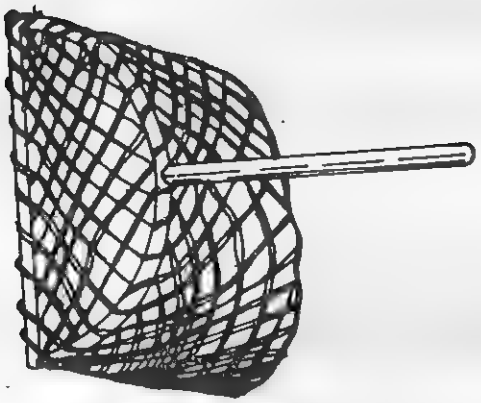


Fig. 15·2 : A sweep net.

Material Required

D-shaped sweep net, pooter, knife, hand lens.

Procedure

Look at the different parts of the tree carefully, and decide on the different places on or in it where animals might live. You can catch the animals in various ways.

(a) Using a D-shaped sweep net to sweep through the leaves, you can collect quite a lot of animals.

(b) Shaking a branch of the tree over an upturned umbralla will dislodge animals.

(c) A 'pooter' is useful for removing small delicate organisms from the net, the umbrella, or the surface of the trunk, leaves, or flowers.

(d) A knife is useful for pulling off old bark to see the animals underneath it, or for probing into interesting-looking holes in the tree. Try not to damage the tree.

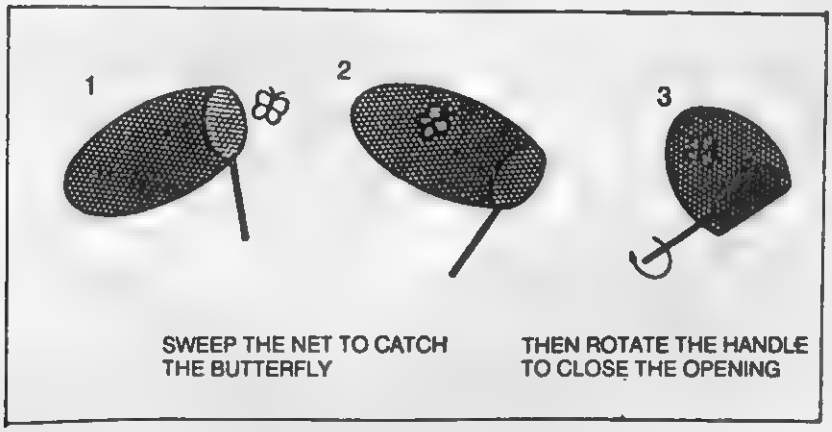


Fig. 15·4 : How to use an insect net or sweep net.

ORAL QUESTIONS

Q. 1. *Define an ecosystem ?*

Ans . Ecosystem is an interacting system of biotic communities together with their physical environment (abiotic).

Q. 2. *Give an example of ecosytsem.*

Ans . Grassland or forest ecosystem or pond or lake ecosystem.

Q. 3. *What are various components of an ecosystem ?*

Ans . 1. Abiotic components (nonliving components) - Physical and chemical factors of environment - like light temperature, water, oxygen, minerals etc.

2. Biotic components (living components) - (i) producers (ii) consumers.

Q. 4. *What is a natural and an artificial ecosystem ?*

Ans . Naturally formed ecosystems are called natural ecosystem and artificial ecosystem is man made.

Q. 5. *Name one artificial ecosystem.*

Ans . Aquarium / crop field.

Q. 6. *How energy travels in an ecosystem ?*

Ans . Energy from sun enters ecosystem through autotrophs (photosynthetic organism) and passes through primary consumers, secondary consumers and tertiary consumers and finally decomposers.

Q. 7. *What is food chain ?*

Ans . A food chain consists of an intricate relationship between producers and consumers.

Q. 8. *What is the difference between an ecosystem and a biome ?*

Ans . An ecosystem may be large or small, natural or artifcial, temporary or natural. A major ecosystem in which natural ecological groupings of plants and animals extend over a large area is called a biome, for example, forests and desert.

Q. 9. *How can you designate a tree as an ecosystem ?*

Ans . A tree consists of all essential components of an ecosystem—producer (tree), consumers (animals living on it), decomposers (fungi on the plant and microbes on the tree and in the soil) and abiotic factors.

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CORE EXPERIMENT 16

POLLUTION

TO STUDY THE PRESENCE OF POLLUTANTS IN AIR AND WATER—PARTICULATE, SO_2, BOD, BIOINDICATOS

Aim : To detect the presence of pollutants in air and water.

Introduction

1. *Pollution* : It is the undesirable change caused directly or indirectly in the physical, chemical, thermal, biological, or radioactive properties of any part of environment which creates a hazard or potential hazard to the health, safety or welfare of any living species. This may include addition of unwanted harmful elements or components to air, water or land or removal of required or useful constituents from the environment. Such desireable substances or constituents that pollute the environment are called *pollutants*.

The pollutants may include—

(i) *Particulates*—The small discrete mass of solid or liquid matter in air such as dust, aerosol, furne, mist, smoke and spray etc. Also spores of fungi, pollen grains of different flowering plants and bacteria.

(ii) CO and SO_2 (Carbon monoxide and sulphur dioxide) in air.

(iii) Insecticides and pesticides in water.

(iv) Radioactive elements and radiations in the atmosphere.

The problem of pollution is very acute in the world and Delhi is said to be the most polluted city.

Experiment 1

Aim : To test the presence of particulate in air.

Material Required

Cork pads or cardboard pieces, Cardboard box, Electric bulbs, White paper, Rubber bands, blade or razor.

Procedure

A. Cut a cork pad into two pieces with the help of a smooth blade or razor or take two cardboard pieces. Pluck a leaf of any plant (e.g., pine needles). Put this leaf between folds of a piece of paper.

Place this leaf along with paper in between two pieces of cork pads or in cardboard pieces. Press the cardboard pieces with two rubber bands on either ends of the cork pads or cardboard pieces so that they are tightly held together. Pull the leaf. Take out the folded paper from the cork pads or cardboard pieces.

Observation

Observe the smear left on the white paper with the help of a hand lens and notice various particulates.

B. Take a cardboard box. Make a hole on one side of the box. Fix an electric bulb holder inside the box. Make your laboratory pitch dark. Glow the bulb and observe the beam of light coming out of the box through hole.

Observation

Tiny particles are seen moving here and there. These are suspended particles in the air.

C. Gently rub the skin of your face with the help of a clean white handkerchief or tissue paper or cotton wool on return from your school.

Repeat the experiment after spending a day outdoor in a busy market or a factory or on a busy road where a lot of buses, cars and scooters are plying. Compare the amount of dirt on both handkerchiefs.

Conclusion

(i) Air contains particulate matter.

(ii) Particulate pollutants in air increase due to factories and vehicles.

D. Place few clean slides with a thin glycerine coating in the open air near window. After some time observe them under the microscope.

Observation

You will find pollen grains, spores of different fungi, soil particles, bacteria etc. being adhered to the glycerine coat.

Conclusion

Particulate air pollutants are:

1. dust particles, 2. carbon particles, 3. pollen grains, 4. spores of fungi, bacteria, 5. smog.

Experiment 2

Aim : To test presence of CO and SO_2 in the air.

Material Required

Filter papers, potassium dichromate, Hydrochloric acid, palladium, chloride or platinum.

Procedure

A. Soak a filter paper in platinum or palladium chloride and place it in open air on road-side having heavy vehicular traffic.

Observation

After sometime the filter paper dipped in palladium chloride truns pink, green or balck because of reduction of chloride by carbon monoxide (CO).

B. Place a filter paper soaked in an acidifed potassium dichromate along the side of a busy road.

Observation

Tne filter paper soaked in acdified potassium dichromate turns green because of its reaction with SO_2.

Conclusion

The above two experiments indicate that roadside air contains (O and SO_2) as pollutants.

Experiment 3

Aim : To test the presence of particulates in a sample of water collected from a local pond or lake.

Material Required

Cardboard box, electric bulb, test tube, water samples.

Procedure

Prepare a Tyndal set up to test turbidity by making a pencil size hole in a cardboard box and fixing a light source (electric bulb) inside the box.

Place the beaker containing water sample, right in front of the hole in the box. Make your laboratory pitch dark and light the bulb. Observe the sample of water through the hole.

Observation

Particles in the water become visible which were not otherwise. Compare the turbidity of water in sample of water from different sources.

Experiment 4

Aim : ***To test oxygen content in a sample of water.***

Material Required

Burette, glass rod, pipette, stand, beaker, Phenosaffaranin (phenophthaline + saffaranin can be used). Fehling solution - B, samples of water.

Theory

Oxygen reacts with ferrous sulphate to convert it into ferric sulphate precipitate. Here phenosaffaranin acts as an indicator. Perform the experiment in the following way.

Procedure

(1) Fill a burrette with ferrous sulphate.

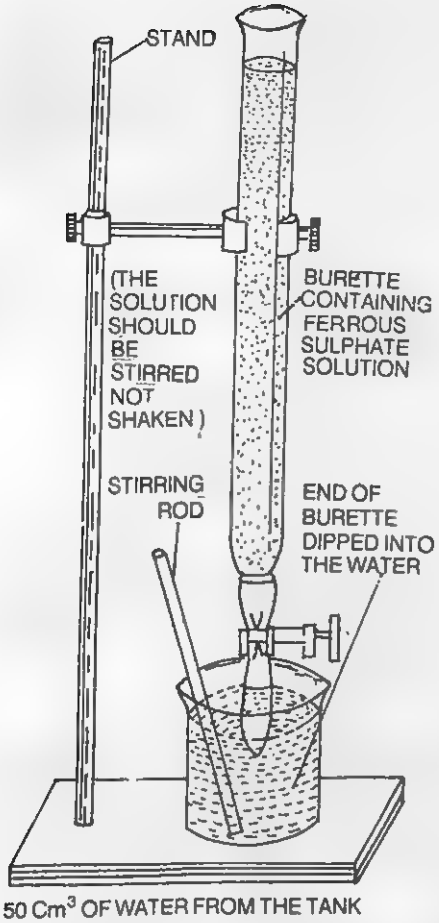

Fig. 16·1 : Estimation of oxygen content in water.

(2) Take 50 ml. of water to be tested in a beaker with the help of a pipette. Keep the pipette end touching the beaker.

(3) Add 3 drops of phenolaffaranin to this water sample.

(4) Now add 10 ml. of Fehling solution B to this.

(5) Fix burette on the stand and place the end of the burette in the water as shown in the Fig. 16.1.

(6) Open the screw and run the ferrous sulphate sol. till the colour of the dye disappears.

(7) Record the initial and final readings of the burette.

(8) Repeat this experiment for different samples of water and compare the amount of ferrous sulphate needed for pond or particular river water and purified tap water.

Conclusion

The amount of ferrous sulphate used by different samples of water indicates the % of oxygen present in water samples.

Experiment 5

Aim : ***To calculate biochemical oxygen demand (BOD) of various samples of water taken from local ponds, lakes or river.***

Material Required

Burette, pipette, beakers, rod, stand, water samples, Fehling solution - B, phenophthalene plus safranin (i.e. phenophthalein in safranin).

Procedure

1. Collect water samples from different sources of water or from different levels of river.

2. Measure the oxygen content of these samples as discussed in experiment 4.

Particulars	Sample I	Sample II	Sample III	Sample IV
Oxygen content in freshwater	A			
Oxygen content in water after 5 days	B			
Difference	A – B =			

3. Keep these water samples at room temperature for five days.

4. Measure oxygen content of these samples after five days.

Observations

Record your reading of oxygen contents of water samples in the form of a table as given on page 124.

Find out the difference in the two readings of oxygen content of each sample.

Conclusion

The sample of water which has less amount of oxygen after five days has high BOD. This indicates the presence of large number of microorganisms. This shows a high level of pollution.

Experiment 6

Aim : To study water pollution bioindicators.

Material Required

Microscope, slides, coverslips, sulphuric acid, ammonium molybdate sol. 0.5% sol. of diphenylamine in conc. sulphuric acid.

Procedure

Collect samples of water from ponds which have algal bloom. Bring these samples to the laboratory for testing. Collect clean water from a clear pond. Use it as a control.

Test I - Take 3 ml. of water from water sample in a test tube and add a few drops of ammonium molybdate solution. Appearance of yellow ppt. or yellow colour shows presence of phosphates.

Test II - Take 3 ml of water from water sample in a test tube and add few drops of 0.5% solution of diphenylamine in conc. sulphuric acid. Appearance of blue colour shows presence of nitrate.

Test III - Concentration of oxygen in a sample can be tested in the sample as discussed in experiment 4.

Test IV - Smell the water collected from a pond which has algal bloom.

Test V - Shake the sample collected. Take a few drops on a clean slide. Spread the drop to make a thin film and allow to dry. After drying, pass the lower surface of slide through the flame of a gas burner or spirit lamp so as to fix the bacteria to slide.

Now add a drop of methylene blue. Keep it for two minutes and then wash. Observe the slide under the compound microscope. Study various types of bacteria, protozoans, diatoms, worms and crustaceans.

Test VI - Make a temporary slide of algae collected along with water sample and study under the microscope. Sketch and indentify. Repeat the procedure with all the samples.

Conclusion

It means pond water rich in algae bloom contains algae, bacteria, protozoans, diatoms, worms, crustaceans and larvae etc.

Experiment 7

Aim : *To study soil bioindicator.*

Fig. 16.2 : An indicator plant, Suaeda fructicosa. The abundance of this plant in an area indicates high salinity of the soil. A. Branched shoot. B. Part of the shoot enlarged to show the succulent leaves and fruit.

Material Required

N/10 H_2SO_4 , $AgNO_3$, HCI, $BaCI_2$ sol., beakers, test tubes.

Procedure

Visit nearby area and find out place where 'bui' or lonia (*Suaeda fructicosa*)/ salt wort (*Salsola baryosma*) grow luxuriantly.

Collect the plant and the sample of the soil. Test the soil salinity as discussed in core Experiment 17.

Conclusion

Suaeda fructicosa is a bioindicator which indicates that the soil in which it is growing is saline.

Precautions

1. Use the chemicals carefully and judiciously.

2. While collecting samples of water, don't go into deep water.

3. Where ever possible, keep a control for comparison.

ORAL QUESTIONS

Q. 1. *What is pollution ?*

Ans . *Pollution* is presence of undesirable substances in any part of the environment which create a hazard or potential hazard to health, safety or welfare of human beings or any other living species.

Q. 2. *What are pollutants ?*

Ans . The pollutants are those undesirable substances whose presence pollutes the environment and posses health hazard.

Q. 3. *What do you mean by particulates or particulate particles ?*

Ans. *Particulates* are small descrete particles of solid matter in air such as dust, smog (Carbon), fumes, aerosol and spray etc.

Q. 4. *Name any five air pollutants.*

Ans . Pollutants of air are dust particles, perfume, CO_2, SO_2, aerosol etc.

Q. 5. *What is the effect of SO_2 when it is present in excess in the atmosphere ?*

Ans. High concentraction of SO_2 destroys bronchial cilia. It causes bronchitis by damaging the lung mucus membrane.

□ □

CORE EXPERIMENT 17

SOIL

PHYSICAL AND CHEMICAL ANALYSIS OF SOIL pH

Aim : ***To study physical and chemical characters of soil*** **(pH).**

Material

Soil Thermometer, Munsell soil colour chart, cardboard, handlens; universal indicator, distilled water, procelain tile, electrometer (pH meter), standard buffer, beaker, wide mouth bottle.

Theory

Soil is the uppermost layer of earth crust. It forms an important habitat for large number of terrestrial organisms and plants. It provides support, water, nutrients and oxygen to plants. Study of ecologically important characteristics of soil is very essential. This includes physical characteristics and chemical nature of soil. Study of soil is called pedology. Soil is dynamic. Its nature changes with time.

A. Study of Physical Characteristics of Soil

Physical Characteristics Include :

1. *Temperature* : Soil temperature is measured by using soil thermometer. The bulb is buried in the soil upto the desired depth and temperature is read on the dial.

2. *Soil colour* : Soil colour is an indicator of soil fertility and has formed the basis of naming soil type. It also helps in distinguishing soil horizons. Soil colour is influenced by the presence of organic matter, iron and manganese.

Procedure for Identifying Soil Colour

Munsell soil colour chart is used to identify the colour and type of soil. It contains standard colour chips arranges systematically on cards carried in a loose note book.

Spread the soil uniformly over a cardboard and select the card which contains matching colour chips. Each card carries colour chips of constant hue represented by symbol in the upper right hand corner. The numbers printed below each colour chip indicate its value and chroma respectively. Note the colour symbol and number on the card. For example,

3. *Soil Texture* : *Soil texture* refers to the relative proportion of its constituent particles of different sizes. Soil texture is of considerable ecological interest as it influences the flora and fauna :

(i) Particles more than 0.02 mm diameter (i.e. *sand* and *gravel*) provide physical support.

(ii) Particles less than 0.02 mm diameter (i.e. *silt* and *clay*) determine water-holding capacity and nutrient availability.

Name of the soil particle	*Diameter of the particle in m.m.*	*Chemical composition*
More than 2.00	Gravel	—
2.00—0.20	Coarse sand	Silica
0.20—0.20	Fine sand	Silica
0.20—0.002	Silt	Silica
Less than 0.002	Clay	Alumina silica

Soils are classified into 7 textural types depending upon their particle size.

Experiment : *Observation of soil texture of a soil sample and its solid components*

Texture can be determined in the field or accurately in the laboratory by mechanical analysis.

Test 1. Examine soil sample under hand lens for size of soil particles and feel between fingers in dry as well as moist state.

Test 2. Squeeze small amount of soil between thumb and finger and judge the texture.

Test 3 : Take about 50 gms of soil from the sample collected in a measuring cylinder of 250 ml. Add 200 ml. water. Shake well and let the soil particles settle down.

Observation

Heavy soil particles settle down first and lighter ones afterwards. Humus floats on the water surface. Observe these layers carefully and record your observations in tabular form as under :

S. No.	*Name of soil particle from top to bottom*	*Thickness of the layers*	*Colour*	*Approximate size of particles*	*Any other feature*
1					
2					
3					
4					
5					
6					
7					

S. No.	*Soil class*	*Texture*	*Percentage*		
			Sand %	*Slit %*	*Clay %*
1.	Sandy soil	Loose, coarse grained	85-100	0-15	0-15
2.	Sandy loam	Loose, coarse but somewhat coherent	30-80	0-50	0-20
3.	Loam	Fairly smooth, slightly plastic, mallow and gritty	23-52	38-50	7-27
4.	Silt Loam	Forms puddle when moist, soft and floury when pulverized, forms easily breakable lumps	0-50	50-88	0-27
5.	Clay loam	Fine textured, when pinched between thumb and finger forms a thin ribbon, can be kneeded, suitable for plant growth.	20-80	15-53	20-30
6.	Clay	Fine textured,	0-59	59-0	31 or more
7.	Silt clay loan	Fine, quite plastic becomes water logged with poor air circulation.	0-20	40-73	27-40

B. Study of Chemical Characteristics of Soil

Chemical properties of soil are studied under two headings - soil components - like percentage of oxygen, iron, calcium, silicon, sodium, potassium etc and 2.pH.

1. Determination of pH of Soil

pH of soil depends upon the relative amount of adsorbed hydrogen ions and adsorbed metallic cations. Increased percentage of hydrogen ions makes soil acidic. Predominance of metallic cations like (Ca^{++}, Mg^{++}) makes soil alkaline.

Procedure

1. Universal Indicator Method — Universal indicator is a mixture of different indicators having different critical pH. It shows whole range of spectrum colours from red to violet for values ranging from 3—11.

1. Shake thoroughly a small spoonful of soil sample, equal amount of *barium sulphate* and about 20 ml water in a test tube.

2. Allow it to stand.

3. Remove the clear supernatant or a porcelain tile.

4. Add equal amount of universal indicator.

5. Match the colour of solution with colour chart provided with the indicator bottle.

6. Note the pH of supernatant.

2. Electrometric Method

When a glass electrode is immersed in the soil suspension, the electric potential developed across a glass membrane is measured by an electric pH meter.

1. Prepare standard buffer solution of pH - 4.00 by dissolving 10.2 gms. potassium biphthalate in water. Dilute it to 1 litre.

2. Standardize the pH meter with the buffer prepared.

3. Remove electrodes from the buffer solution and rinse with water.

4. Weigh out 20 gm. soil and dissolve in 100 ml of distilled water in a wide mouth bottle.

5. Fix the stopper and shake well for 1 hour.

6. Shake the bottle and dip electrodes into the soil suspension.

7. Read pH in the pH meter.

Precaution

1. Glass electrodes shall be handled carefully.

2. Wash electrodes with water immediately after use and during storage keep them immersed in distilled water.

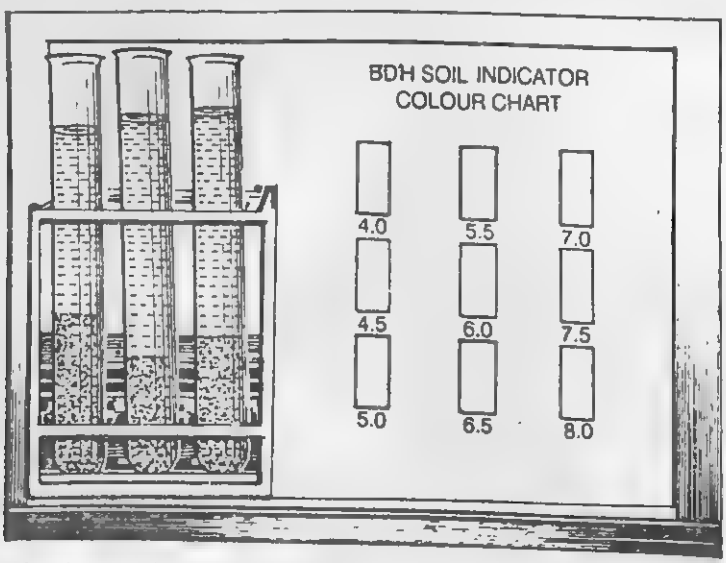

Fig. 17.1 : Diagram showing set of universal indicators and indicator colour chart used to determine pH of soil.

SALTS IN THE SOILS

All the soils contain small quantity of soluble salts. These salts play an important role in soil fertility. The concentration and composition of these salts effect osmosis in plants and increase pH of the soil. These salts may be put into two groups:

1. Saline salts

2. Alkaline salts.

Saline soil : When soil contains excess soluble salts of Cl and SO_4 it is called saline soil. Generally, on the surface of such soil white patches develop in dry conditions. This condition develops due to the presence of NaCl and Na_2SO_4 in the soil.

Alkaline soil : When soil contains carbonates and bicarbonates of sodium and magnesium etc., the soil is known as alkaline soil.

Analysis of soluble salts of the soil :

Amount of salts present in the soil is about 0.1% therefore, a concentrate solution of the soil extract is necessary to test inorganic salts of the soil.

Generally soil is tested for :

1. Chloride (Cl^-), 2. Sulphate (SO_4^-) 3. Carbonate (CO_3^-) and bicarbonate (HCO_3^-) 4. Calcium (Ca^{++}), 5. Magnesium (Mg^{++}), 6. Nitrate (No_3^-), 7. Phosphate (PO_4).

EXPERIMENT 1

Aim : ***To test the presence of inorganic salts in the soil.***

Material Required :

Test tube, Distilled water, Beaker, Barium chloride solution, Soil, Sulphuric acid, Conical flask, Ammonium molybdate, 0.5% solution of dipthenyl amine, $AgNO_3$, Methyl orange.

Procedure :

Take 100 gm. of the soil sample in a 750 ml. conial flask. Add 500 ml. of distilled water to this conical flask and shake it well for an hour or leave it overnight, so that all the soluble salts may dissolve in water. Now, filter this and collect the (water extract) filtrate. Test the filtrate in the following manner :

A. Test for Chloride : Take 20 ml. of water extract (filtrate) of the soil in a beaker. Add 10 cc of $N/10H_2SO_4$ to neutralize carbonates and bicarbonates present in the filtrate. Now add $AgNO_3$ to this beaker. Appearnce of white ppt. indicates the presence of chloride.

B. Test for Sulphate : Take 20 ml. of water extract in a beaker. Add 2-3 ml. of conc. HCl and boil. Add $BaCl_2$ sol. to this beaker. Appearance of white precipitate shows presence of sulphate.

C. Test for Calcium and Magnesium : Take 100 ml. of water extract and add 20 ml. of glacial acetic acid and 3-4 drops of methyl orange indicator. Now add NH_4OH (ammonium hydroxide) to this solution so that the pink colour of methyl orange disappears and then add ammonium oxalate. Calcium will precipitate as calcium oxalate.

Filter this solution through Whatsman filter paper and collect the filtrate. Take ths filtrate of calcium oxalate and concentrate it by evaporating water during boiling, to 20 ml. Add few drops of conc. HCl and methyl orange to this solution. Then add 2—3 ml. freshly dissolved sodium biphosphate in cold condition. To this solution add few drops of NH_4OH till colour of methyl orange turns to golden yellow. Add few more drops of ammonium hydroxide, stir it and leave for some time. The appearance of ppt. shows the presence of Mg^{++} in the soil.

D. Test for Carbonate and Bicarbonate : Take soil filtrate in a test tube, and add a few drops of conc. H_2SO_4 (heat, if needed). Evolution of effervescence shows presence of carbonates and bicarbonates in the soil.

E. Test for phosphate : Take 10 ml. of soil filtrate and add a few drops of ammonium molybdate soil, conc. HNO_3 and NH_4NO_3. Appearance of yellow colour shows the presence of phosphates in the soil.

F. Test of Nitrate : Take 10 ml. of soil filtrate in a test tube, add 0.5% of diphenylamine in conc.H_2SO_4. Blue colour indicates presence of nitrate in the soil.

Organic content	*pH of the soil*	*Chloride*	*Sulphate*	*Corbonate*	*Phosphate*	*Calcium*	*Magnesium*	*Nitrate*

EXPERIMENT 2

Aim : *Analyse a given sample of garden soil.*

Perform the above mentioned test and fill up the Table given above :

Put (+) sign for positive test and (–) sign for negative test. Fill the pH after comparing from pH chart.

Note : To test presence of Iron and aluminium oxides. Prepare HCl extract of the soil as follows :

Take 10 g of heated soil in a beaker. To this beaker add 200 ml. of HCl. Cover the mouth of the beaker and boil for an hour. After an hour, cool and filter the HCl solution, collect the filtrate. This filtrate is known as HCl extract of the soil.

Test for Iron and Aluminium : Take 100 CC of HCl extract of the soil and add 200 ml. of conc. HNO_3. Boil for 5 minutes. Cool it and add 2.0 g of solid NH_4Cl or 20 ml. of NH_4Cl solution. Stir it and then add NH_4OH. Precipitate of sesquioxide will appear.

This HCl extract may be used to detect Fe, Al, Ca, Mg, P and K.

EXPERIMENT 3

Aim : ***To test the presence of organic matter in the soil.***

Material Required

Hydrogen peroxide (6%), Soil, Beaker 250 ml.

Procedure

Take 20 gm of soil in both beakers A and B. In beaker A add 6% Hydrogen peroxide so that it covers the soil. In beaker B add water to cover soil. Leave it to effervence. The reaction can be speeded up by slow heating. When reaction ceases, add sufficient water into both beakers A and B to clear the liquid. Compare the colour of the soil settled in both beakers.

Note : It is the property of the hydrogen peroxide to bleach the organic matter (humus).

EXPERIMENT 4

Aim : To examine that soil contains air.

Material Required

Pot with soil, Water.

Procedure

Take a pot with dry soil. Add water from a beaker to this pot and observe. You will observe rising of bubbles. These are air bubbles which are coming out because water it taking the place of air in the soil.

EXPERIMENT 5

Aim : To test the presence of water in the soil.

Material Required

Test tube, Soil sample, test tube holder, Spirit lamp.

Record your observations in the following table :

Height of water	*5 minutes*	*10 minutes*	*15 minutes*	*20 minutes*	*25 minutes*	*30 minutes*
In sand In clay In loam						

Procedure

Take few gm. of apparently dry soil in a test tube. Hold it with the test tube holder and heat on a spirit lamp for a minute or so. Note that the tube should be kept slanting while heating the soil sample. You will observe deposition of water vapours near the mouth of the test tube. After 5 minutes record the rise in the level of water in soil of the glass tube. Take at least five readings (every readings after 5 minutes).

ORAL QUESTIONS

Q. 1. *What is clay ?*

Ans . *Clay* soil is formed of small sized particles of colloidal dimensions. These have small interspaces, high plasticity and possess high water holding capacity. Clay is not suitable for plant growth because water and air cannot circulate freely.

Q. 2. *What is water holding capacity ?*

Ans . Water holding capacity of soil is the amount of water held by a saturated soil. It is measured by weighing a unit volume of dry soil before and after it has been immersed in water for 24 hours.

Q. 3. *What is humus ?*

Ans . *Humus* is the dark coloured top layer of the soil, formed of organic matter in various stages of decomposition. It is important for plants for proper growth.

Q. 4. *What is microfauna ?*

Ans . The *microfauna* of soil includes microorganisms like bacteria, protozoans, rotifers, copepods, crustaceans and nematodes etc.

Q. 5. *What determines soil permeability ?*

Ans . Soil permeability is determined by pore size or the space between soil particles.

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CORE EXPERIMENT 18 (A)

TISSUE SYSTEMS

(A) PREPARATION OF STAINED TEMPORARY SLIDES OF FREE HAND TRANSVERSE SECTIONS OF ROOT, STEM AND MACERATED WOODY TISSUE. (B) EXAMINATION OF A SHOOT AND ROOT MERISTEM FROM A PREPARED SLIDE

Aim : To prepare temporary stained glycerine mounts of transverse sections of roots and stems of dicot and monocotyledonous plants.

(a) To study the internal organs and their functions in the young stem and root.

(b) To study the internal organs and their functions in the sections showing secondary grwoth.

(c) To study the internal structure of dicot and monocot leaves.

Materials Required

1. Sharp razor or new blades.

2. Brush, dropper, needles.

3. Watch-glass or petridishes.

4. Microscopic slides and coverslips.

5. Saffranin, haematoxylin and glycerine.

6. Compound Microscope.

7. Pith—any suitable material to hold stems and roots.....a thick petiole of Plumeria, cauliflower, carrot, pumpkin can be used. Calotropis preserved in 10% formalin or methylated spirit has been very useful.

8. Dicot root and stem of Sunflower. Young and old gram can also be used for its root.

9. Monocot root—Asparagus.

10. Monocot stem—maize.

11. Permanent slides of dicot and monocot leaves.

Procedure—Section Cutting

Use of pith : Make a narrow hole in the pith by digging (scooping) with the help of a needle. The size of the hole should be enough to fit in the material. You may also cut the pith into two halves and make grooves in both the halves. Place the material which fits in the groove but should not be very loose or tight. Hold the pith along with the material between thumb and first finger of your left hand. The pith must be held in a horizontal plane so as to get transverse sections. Moisten the pith and dip the razor or blade in water and pass it over the pith instantly, so that with one jerk the razor can cut a section of the pith in which case, material will also be cut. Repeat this 8-10 times and collect the sections in a watch glass containing water. Select the sections with the help of a brush and place them on a glass slide along with a drop of water. Study the sections under the low power of a microscope and select the best section which is thin, complete and transversely cut. If the section is thin and transverse you will be able to see the outline bright. If the section is oblique then black dark areas will be seen in the tissues since the cells have been cut partly length-wise.

Staining : Use saffranin for dead tissue and haematoxylin for living tissue. Saffranin stains thick-walled lignified tissues in red outline and haematoxylin satins thin-walled living tissue blue.

Select two good sections, leave them on slide and drain off the water. Place a drop of saffranin on the sections and wait for 20-30 seconds. Transfer them into watch glass containing acid water, where excess of stain will be washed out. Wash once again in fresh clean water and mount them on a clean dry slide in two drops of glycerine. A gentle tap on cover slip will help in even distribution of glycerine.

If the sections are thin and complete they can be treated with haematoxylin for 15-20 seconds before mounting.

Observations :

Different types of tissues can be seen in the sections. Many of these tissues are similar in structure but their arrangement varies in root and stem.

Precautions:

1. The pith must be held horizontally to get transverse sections.

Points of Identification

S. No.	*Stem*	*Root*
1.	Outermost layer of cell is called **epidermis.** It is surrounded by a layer of cuticle.	1. Outermost layer is known as **epiblema.** which is thin walled and no cuticle is found.
2.	**Shoot hairs** are multicelular. They are borne on the epidermis.	2. **Root hairs** are unicellular extentions of epiblema cells.
3.	**Hypodermis** or cortex can be divided into collenchymatous, sclerenchymatous and parenchymatous layers.	3. Cortex consists of thin walled parenchymatous cells. Food is stored here.
4.	**Vascular Bundles—**	4. **Vascular Bundles—**
	(i) Collateral—Xylem and phloem are situated on the same radius.	(i) Radial—xylem and phloem are situated on two separate radii.
	(ii) Endarch—Protoxylem is situated towards centre and the metaxylem towards periphery.	(ii) Exarch—Protoxylem is facing outside and the metaxylem is towards centre.

Identification of Dicot and Monocot Stem

	Dicot Stem	*Monocot Stem*
1.	Mostly **hypodermis** is formed of patches of collenchymatous cells.	1. **Hypodermis** is formed of selerenchymatous cells.
2.	Endodermis is well defined.	2. Endodermis is absent.
3.	**Pericycle** consists of parenchymatous and sclerenchymatous tissue arranged in alternate manner. This layer lies between Endodermis and vascular bundles.	3. Pericycle is absent. Thus there is a continuous mass of parenchyma upto the centre. This is known as ground tissue.
4.	**Stelar region—**	4. **Stelar region—**
(i)	Medullary rays are present. These consists of thin-walled polygonal or radially elongated cells.	(i) Medullary rays are absent.
(ii)	Vascular bundles are arranged in a ring.	(ii) Vascular bundles are scattered. Each vascular bundle is surrounded by a bundle sheath.
(iii)	Vascular bundles are collateral and open, i.e., cambium is present between xylem and phloem.	(iii) Vascular bundles are collateral and closed, i.e., cambium is absent.
5.	Pith—From vascular bundle to the centre of the stem are present thin-walled living cells with intercellular spaces. These cells form the pith.	5. Pith is not found, only ground tissue is seen.

Identification of Dicot and Monocot Root

Dicot	*Monocot*
1. **Vascular bundles—** (i) 2-6 in number. (ii) Xylem diarch to hexarch, i.e., 2 to 6 (iii) Cambium appears later. 2. Pith small or absent.	1. **Vascular bundles—** (i) More than 6. (ii) Xylem polyarch, i.e, more than 6 arches. (iii) Cambium absent. 2. Pith large and well-developed.

2. Saffranin is to be used to stain only the lignified tissues; over-staining can be removed by washing in acid water.

3. If acid water is used, sections must be washed thoroughly, otherwise any trace of acid left will remove the stain and make a smear in the glyerine mount.

4. Air bubbles must be avoided in the sections, these often appear if the pith (with material) and the razor are not well covered with a film of water.

5. Discard the incomplete and oblique sections.

DICOT STEM (SUNFLOWER)

EXPERIMENT 1

To prepare a stained mount of free hand transverse section of a young dicot (sunflower—Helianthus) stem.

Procedure : Cut numerous transverse sections of the young dicot stem provided. Select a good section. Stain with saffranin. Mount it. Observe it under the microscope.

Observation : Observe the slide under compound microscope and identify the following :

(i) **Epidermis :** Outermost one cell thick layer, bearing some multicellular hair.

(ii) **Cortex :** This region is divisible into three distinct parts.

(a) **Hypodermis :** Situated below the epidermis, consists of 4 to 5 layers of collenchyma.

(b) **General Cortex :** Consisting of large rounded, oval, thin walled parenchymatous cells with intercellular spaces situated below the hypodermis. Some isolated resin ducts are also present in the general cortex.

(c) **Endodermis :** Innermost layer or cortex having barrel shaped cells.

(iii) **Pericycle :** Situated between endodermis and vascular bundles. It consists of semilunar patches of sclerenchyma and intervening masses of parenchyma. The sclerenchyma patch found above the phloem is known as **hard bast.**

(iv) **Medullary rays :** Situated between the vascular bundles consisting of thin walled parenchymatous cells.

(v) **Pith :** Centrally placed, extending from below the vascular bundles to the centre of the stem. It consists of rounded or polygonal parenchymatous cells with intercellular spaces.

(vi) **Vascular Bundle :** Arranged in a ring below the pericycle. These are collateral and open. Each vascular bundle consists of the following :

(a) **Phloem :** Outermost, consisting of sieve tubes, phloem parenchyma and companion cells.

(b) **Cambium :** Situated between phloem and xylem. It consists of thin walled, rectangular, small cells arranged in radial rows.

(c) **Xylem :** Situated below the cambium region, it is differentiated into metaxylem and protoxylem.

Metaxylem : It is outer, consisting of vessels of bigger diameter which are reticulate and pitted.

Protoxylem : It lies towards the centre and consists of annual, spiral and scalariform vessels.

Points of identification :

(i) Multicellular hair present on the epidermis.

(ii) Hypodermis collenchymatous.

(iii) Xylem-Endarch (metaxylem towards periphery and protoxylem towards centre).

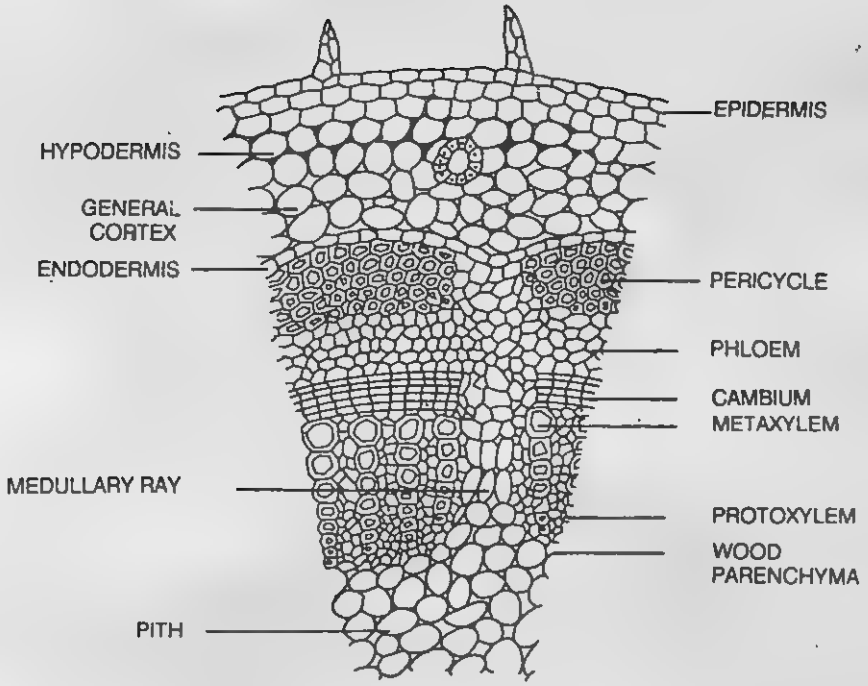


Fig. 18·1 : T.S. dicot stem sunflower.

(iv) Vascular bundles are arranged in a ring.

(v) Vascular bundles conjoint, collateral and open.

Inference. The given specimen is the section of dicot stem.

DICOT STEM (CUCURBITA)

EXPERIMENT 2

To prepare a stained mount of free hand transverse section of a young Cucurbita stem.

Procedure :

Cut and then mount a thin section of cucurbita after staining with saffranin.

Observation :

Observe the slide under hand lens or dissecting microscope. Note five ridges and five furrows giving a distinct appearance to the section. Note ten vascular bundles arranged in two rows—five in outer row are smaller and lie corresponding to the ridges, five inner vascular bundles are larger and are placed corresponding to furrows. A central cavity is also present. Observe the mount under compound microscope and identify the following with the help of diagram given here.

(i) **Epidermis :** Outermost layer, one cell thick, cells flattened and closely attached with cuticle, a few stomata and multicellular hair present.

(ii) **Cortex :** It is differentiated into the following:

(a) **Hypodermis:** It consists of five to seven layers of collenchyma present in the ridges, while two to three layers are present in the furrows. These contain chloroplast.

(b) **General Cortex :** It consists of two to three layers of parenchyma cells having chloroplast.

(c) **Endodermis :** It is wavy in outline and situated below the pericycle.

(iii) **Pericycle:** Continuous ring of thick walled, polygonal, lingnified cells (sclerenchyma). It is four to five cells thick.

(iv) **Ground Tissue :** Thin walled parenchymatous cells extending from below the pericycle to the central pith.

(v) **Vascular bundle :** These are bicollateral and open. Ten vascular bundles are arranged in two rows—five in each row. Each vascular bundle consists of (a) two phloem, (b) two cambium and (c) one xylem.

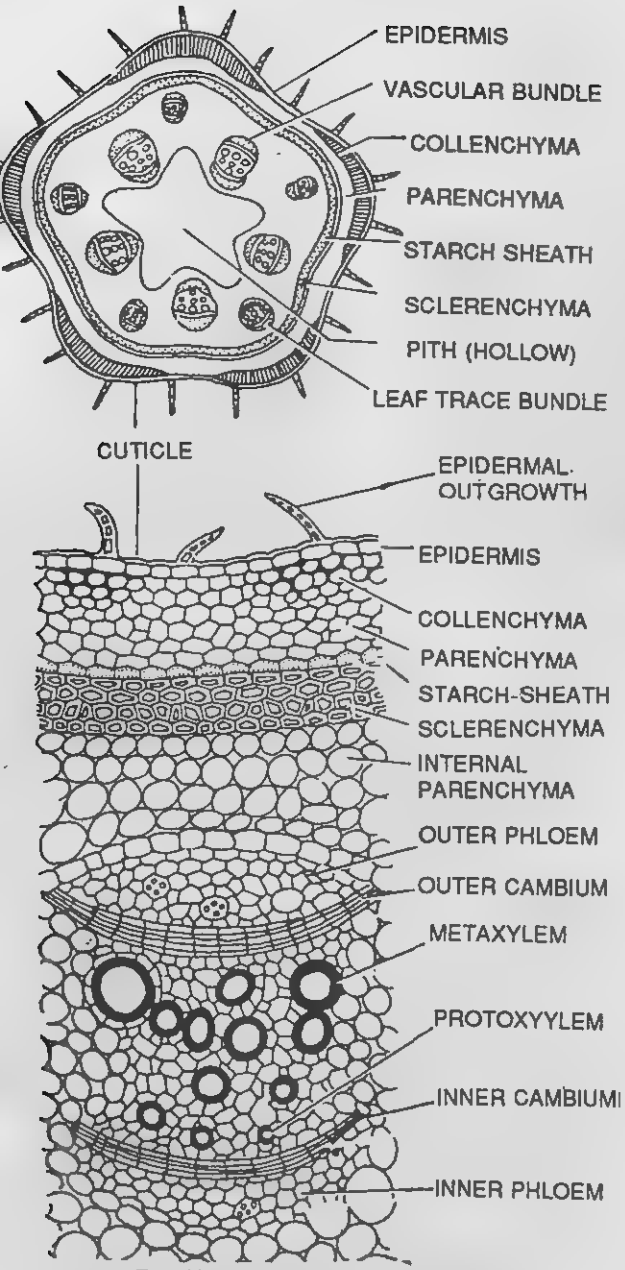


Fig. 18·2 : T.S. dicot stem (Cucurbita)

(a) **Phloem :** Two patches of phloem present, outer plano-convex and inner semilunar. Phloem consists of distinct sieve-tubes with perforated sieve plates. Companion cells and parenchyma are also present.

(b) **Cambium :** Present in two strips—outer many layered and more or less flat while inner cambium is few layered and curved. The two strips of cambium are arranged on either side of the xylem. Cambium consists of thin walled and rectangular cells which are arranged in radial rows.

(c) **Xylem :** Xylem is placed in the centre of the vascular bundle. Metaxylem consists of pitted wide vessels towards outer side and protoxylem towards inner side with narrower vessels. Wood parenchyma is absent. Tracheid and wood fibres are present.

Points of Identification

(i) Multicellular hairs present.

(ii) Hypodermis is collenchymatous.

(iii) Vascular bundles are arranged in rings.

(iv) Xylem is endarch.

(v) Vascular bundles are conjoint, bicollateral and open (cambium present).

Inference : The given specimen is the section of dicot cucurbita stem.

MONOCOT STEM (MAIZE STEM)

EXPERIMENT 3

To prepare a stained mount of free hand transverse section of a monocot stem.

Procedure : Cut and then mount a thin section of maize stem after staining it with saffranin.

Observation : Observe the prepared slide under compound microscope. Identify the following tissues with the help of diagram given here.

(i) **Epidermis :** It consists of a single outermost layer of cells. A thick cuticle extends on the outer surface of the epidermal cells. A few stomata are found distributed in epidermis.

(ii) **Cortex :** Cortex is differentiated into hypodermis and general cortex.

(a) **Hypodermis :** It lies below the epidermis and is formed of two or three layers of sclerenchyma.

(b) **General Cortex :** Below the hypodermis a continuous mass of parenchyma extends to the centre of the stem. It is not differentiated into endodermis and pericycle.

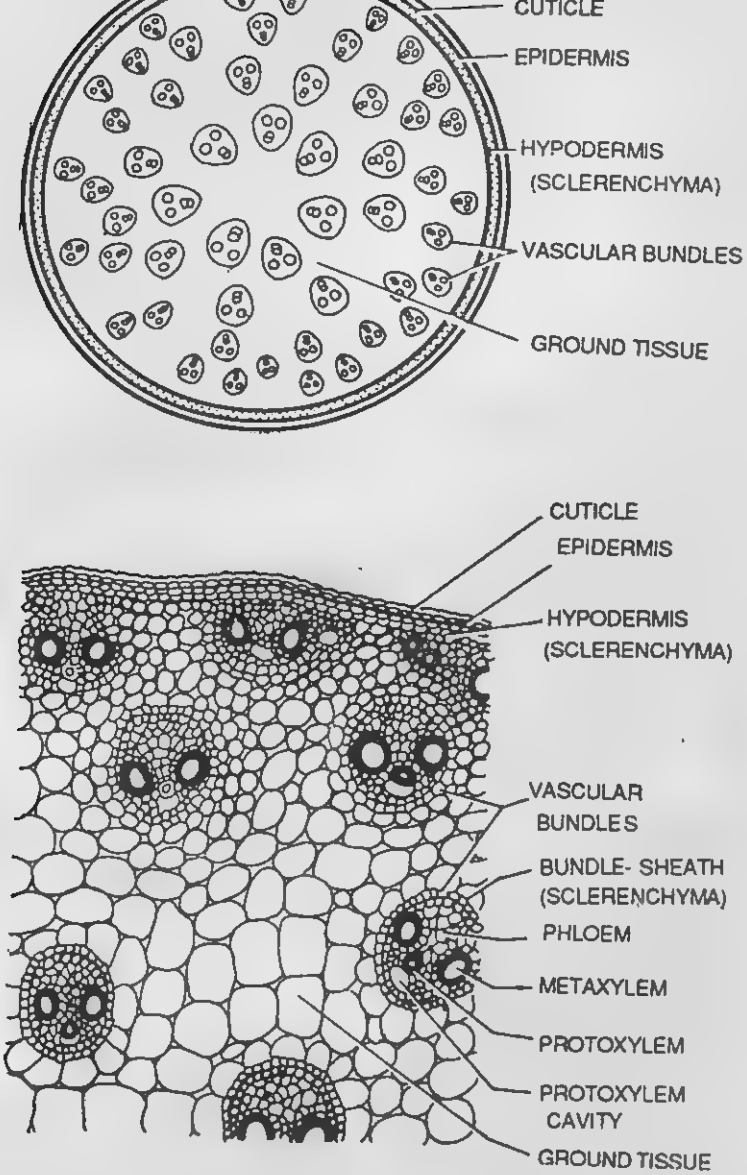


Fig. 18.3 : Vascular bundle of maize stem

(iii) **Vascular bundles :** Vascular bundles are collateral and closed i.e. cambium is absent. They are found scattered in the ground tissue. Vascular bundles towards periphery are numerous, nearer and smaller than the vascular bundles towards centre. The vascular bundles are oval in shape. Each vascular bundle is surrounded with a layer of sclerenchyma called *bundle sheath.* The vascular bundle consists of (a) *phloem* and (b) *xylem.*

(a) **Phloem :** The outer portion of phloem is broken which is known as protophloem. Below protophloem lies metaphloem. Phloem consists of seive tubes and companion cells. Phloem parenchyma is absent.

(b) **Xylem :** Four distinct xylem vessels are arranged in Y shape. The two bigger lateral pitted vessels and the tracheids in between them constitute the **metaxylem.** The two radial smaller vessels which are placed one upon the other form the **protoxylem.** A conspicuous water cavity is present surrounded by wood parenchyma in the protoxylem. This passes down water in the protoxylem vessels and wood parenchyma during rapid growth of the stem.

Points of Identification

(i) Hypodermis is scelerenchymatous.

(ii) Cortex is not differentiated into endodermis and pericycle.

(iii) Vascular bundles are scattered in the ground tissue.

(iv) Vascular bundles are conjoint, collateral and closed i.e., cambium is absent.

(v) Each vascular bundle is surrounded by a bundle sheath.

(vi) Xylem is Y shaped and metaxylem lies towards periphery.

Inference : The given specimen is the section of monocot stem.

DICOT ROOT

EXPERIMENT 4

To prepare a stained mount of free hand transverse section of a dicot root.

Procedure

Cut thin transverse section of dicot root provided. Take a thin section, stain it and mount.

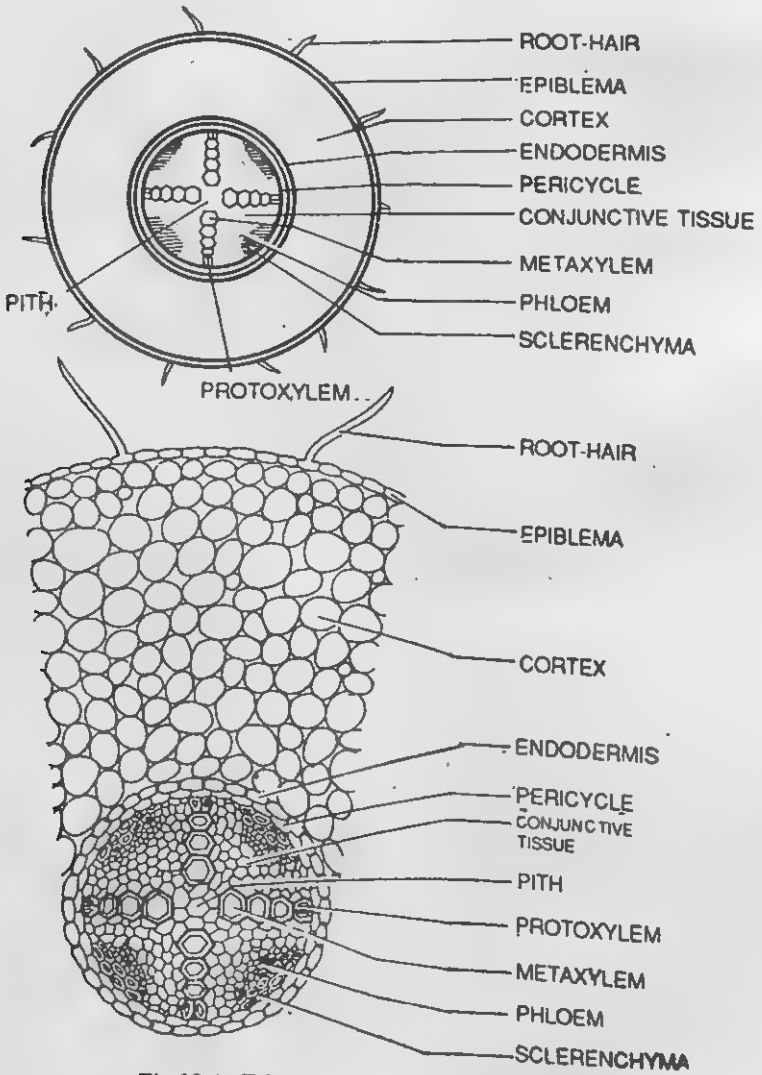


Fig 18-4 : T.S. Dicot root.—A. Diagrammatic, B. Cellular

Observation

Observe and identify the following with the help of diagram.

(i) **Epidermis or Epiblema :** It is the outermost single layer of thin walled cells. Most of the cells of this layer are extended outward to form unicellular root hair. There is no cuticle on the outer surface of epidermis.

(ii) **Cortex :** The parenchymatous cells with inter-cellular spaces below the epidermis constitute the cortex. The thin walled cells of cortex contain leucoplast and store starch grains.

Endodermis : The innermost layer of the cortex is called endodermis. It consists of barrel-shaped closely packed single layer of cells. The radial walls of these cells are thickened.

(iii) **Pericycle :** Below endodermis there is a single ring of smaller and thin walled cells—the pericycle.

(iv) **Conjuctive Tissue :** Constitute the parenchyma lying in between the xylem and phloem bundles.

(v) **Pith :** Pith is almost obliterated or occupies a small area in the centre of the root. Pith, if present, consists of parenchyma.

(vi) **Vascular Bundle :** These are arranged in a ring. Xylem and phloem occupy separate radii. The xylem or phloem bundles varies from 2 to 6. In young dicot, cambium is absent.

(vii) **Phloem Bundles :** Consists of sieve tubes, companion cells and bast parenchyma.

(viii) **Xylem :** The protoxylem lies towards the periphery just touching pericycle. Protoxylem consists of small vessels with annular and spiral lignification. Metaxylem lies towards centre, often meet in the centre to obliterate the pith. It is composed of reticulate and pitted vessels.

Points of Identification

(i) Unicellular hair are present on the epidermis.

(ii) Hypodermis is absent.

(iii) Vascular bundles are radial. Xylem and pholem are present on separate radii.

(iv) Xylem or pholem bundles are less than 6.

(v) Protoxylem lies towards periphery and metaxylem lies towards centre.

Inference : The given specimen is the section of dicot root.

MONOCOT ROOT
(Maize)

EXPERIMENT 5

To prepare a stained mount of free hand transverse section of a monocot root.

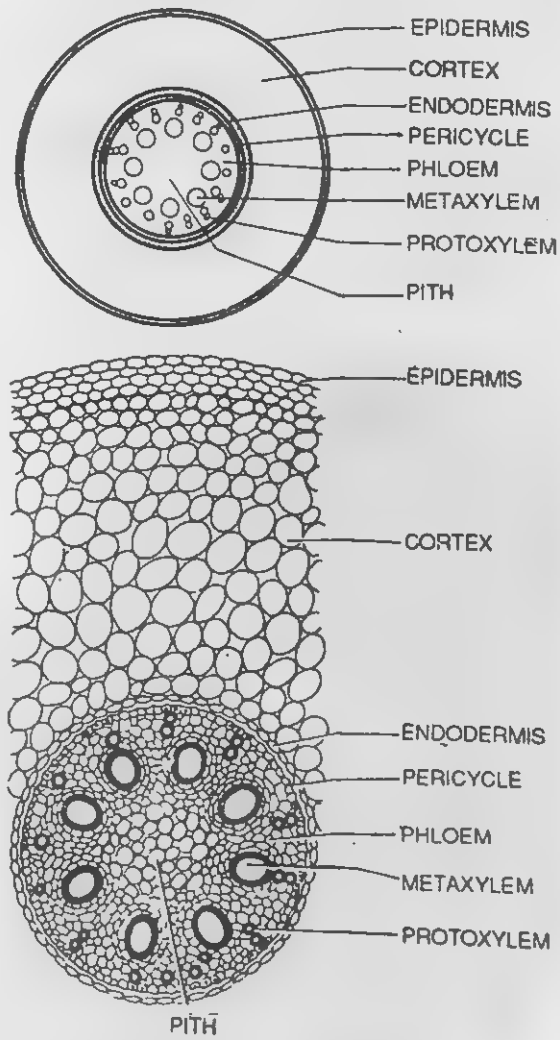


Fig. 18.5 : T.S. Monocot root

Procedure : As in previous exercise.

Observation : Observe and identify the following structures with the help of Fig. 18.5.

(i) **Epidermis or Epiblema :** It is a single outermost layer of cells without cuticle. The epidermis has unicellular root hair.

(ii) **Cortex :** It consists of oval or round, thin walled cells with intercellular spaces.

(iii) **Endodermis :** It constitutes a ring of barrel shaped cells around the steller region. The passage cells in the endodermis are very clear.

(iv) **Pericycle :** It is a single layer of thin walled and small cells with abundant protoplasm.

(v) **Conjuctive tissue :** The parenchymatous tissue between the xylem and phloem bundles is called conjuctive tissue.

(vi) **Pith :** It consists of parenchyma in the central region of the root. It is well developed in monocot roots.

(vii) **Vascular bundles :** Xylem and phloem bundles are placed separately on different radii i.e., vascular bundles are radial. Xylem and phloem bundles are equal in number. Bundles are numerous.

Phloem : Lies just below the pericycle and consists of seive tubes, companion cells and bast parenchyma.

Xylem : Xylem is exarch i.e. protoxylem lies towards the circumference of the root and metaxylem towards the centre of the root. Protoxylem consists of annular and spiral vessels while metaxylem contains reticulate and pitted vessels.

Points of Identification

(i) Unicellular hairs are present on the epidermis.

(ii) Hypodermis is absent.

(iii) Vascular bundles are radial. Xylem and phloem are present on separate radii.

(iv) Xylem or phloem bundles are more than 6.

(v) Metaxylem lies towards centre.

Inference. The given specimen is the section of monocrot root.

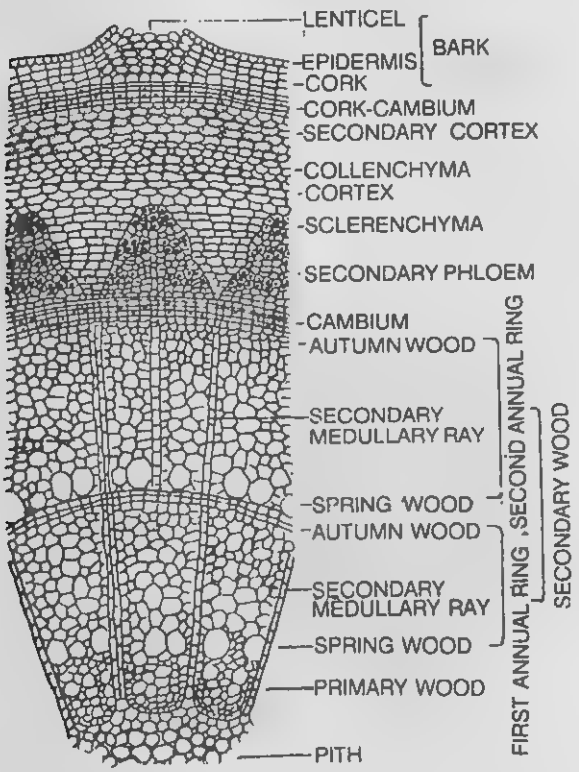


Fig. 18·6 : A dicot stem showing secondary growth in thickness

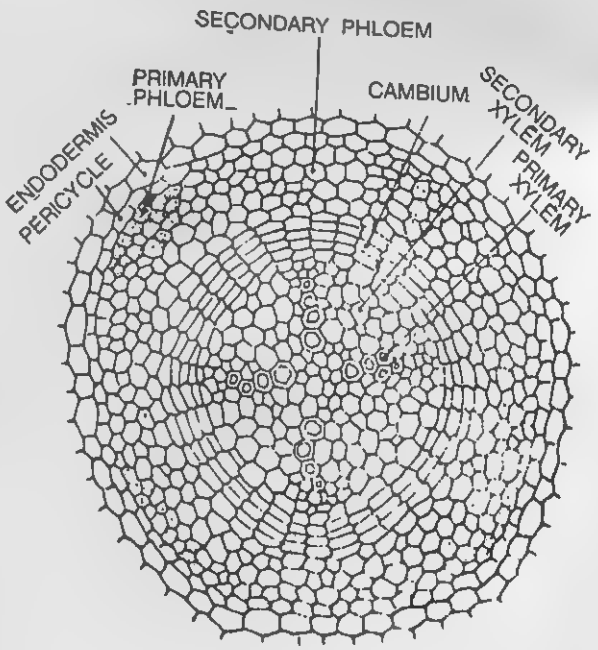


Fig. 18·7 : A dicot root showing secondary growth.

STUDY OF SECONDARY GROWTH IN DICOT STEM AND DICOT ROOT

SECONDARY GROWTH IN DICOT STEM

In the sections of dicot stem the following tissues will be present with prominence.

1. **Epidermis**—Partly crushed and lenticels may be present.

2. **Cortex**—Can be differentiated into following regions :

(a) Cork or phellum—the outer most region of the phellem has mostly dead cells.

(b) Phellogen or Cork Cambium—composed of 2-3 layers of parenchymatous cells.

(c) Secondary cortex or phelloderm—Consists of chlorenchyma and parenchyma.

3. **Pericycle**—It is seen in broken pieces of sclerenchyma or hard bast and parenchyma completes the ring.

4. **Secondary phloem**—The primary phloem is crushed and inconspicuous. Secondary phloem can be seen in a ring consisting of phloem tissue of unequal sized cells.

5. **Cambium ring** is an active ring situated between phloem and xylem. The cells are bric-shaped.

6. **Secondary xylem** is arranged in a ring consisting of secondary tissue with broad xylem tracheids and vessels. The primary xylem points are pushed towards center.

7. **Medullary ray**—Can be located between two wedge shaped vascular bundles.

SECONDARY GROWTH IN DICOT ROOT

(i) **Epiblema** with root hairs is crushed. Lenticels may be seen.

(ii) **Secondary cortex** or phelloderm is not well developed as in the dicot stem. Instead 3-5 layers of parenchymatous or cambium shaped cells can be seen.

(iii) **Secondary phloem** is well developed (2-3 layers)

(iv) **Secondary xylem** is well developed. A major portion of the dicot root is comprised of secondary xylem.

(v) **Primary xylem** is pushed towards pith. The exarch protoxylem points can be seen but in not very old roots. Pith region is obliterated.

(vi) **Cambium ring**—a distinct (2-3 celled) layer of combium can be distinguished between secondary xylem and phloem.

MACERATION

It helps in the study of three dimensional and real nature of cells of a plant or plant parts. In this process the material (stem) is treated with reagents, which dissolve the middle lamellae and thus the different cells are separated from one another. Their slide is prepared for microscopic study. This can be done by using one of the following methods :

1. *Jeffrey's method* : First cut the material into small pieces and remove its air by boiling and

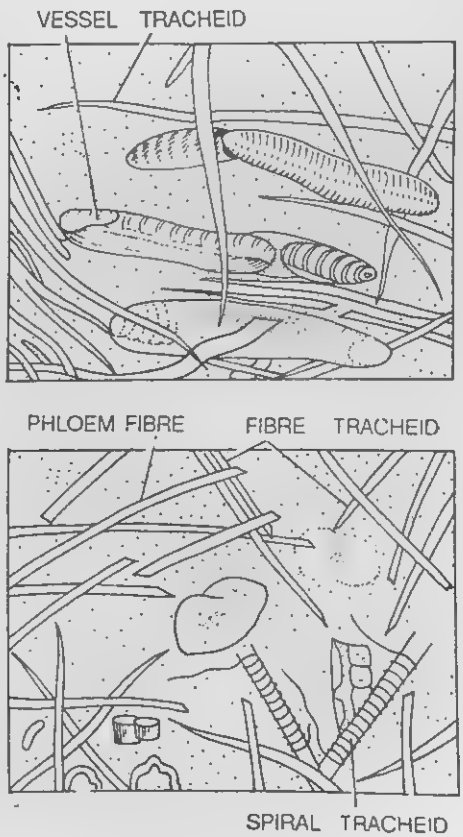


Fig. 18-8 : Macerated woody tissue.

cooling it repeatedly. Now put the material in a test tube containing solution of equal parts of 10% aqueous nitric acid and 10% aqueous chromic acid for 1 to 2 days. (Time varies according to material and the solution may be heated for woody tissues). Crush the material with a glass rod and wash it thoroughly to remove the acids. Now stain the material in 1% safranin solution for 6 hrs. Wash the material thoroughly in water, and mount in glycerine.

2. *Harlow's method*: Put the pieces of material in chlorine water for 2 hours. Then wash the material thoroughly in water and boil it in 3% solution of sodium sulphite for 15 minutes or so. Again wash the material in water and crush it with glass rod. Repeat the process if necessary. Mount in glycerine.

3. *Schultze's method* : Take few pieces of stem in a test tube and add 5 ml. of conc. HNO_3 and few crystals of potassium chlorate. Heat the test tube gently on sand bath or water bath till the material becomes white. Wash the stem piece thoroughly with water. Crush it gently with a glass rod. Observe the material by placing it on the slide under the microscope.

(iii) Solution of 0.10 M concentration of sugar solution brings about the turgid condition in the cells indicates that endosmosis is taking place i.e., concentration of outer sugar solution is lesser then that of the cell sap. Hence the solution acts as a hypotonic one.

Result

Hypertonic solution brings about exomosis. Isotomic solution brings about no change. Hypotonic solution brings about endosmosis.

CORE EXPERIMENT 18 (B)

MERISTEMS

EXAMINATION OF A SHOOT AND ROOT MERISTEM FROM A PREPARED SLIDE

Aim : To study shoot and root meristem from prepared/permanent slides.

Material Required

Microscope, Prepared slides of L.S. of shoot and root apex.

Observation

Observe each slide first under the microscope under low magnification. Draw labelled diagram. Compare the structure you observe with the diagrams given here.

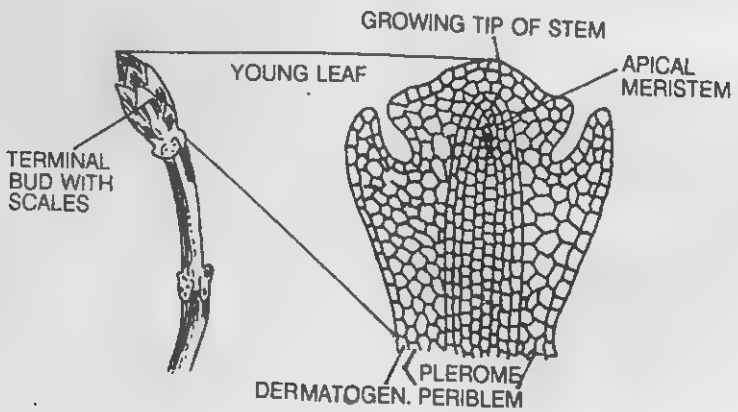


Fig. 18·9 : L.S. of stem tip showing apical meristem.

Meristematic cells are rectangular or isodimetric in shape and rich in protoplasmic contents. They are thin walled with large nucleus. Vacuole is absent, if present they are very small in size. Meristematic cells are metabolically highly active.

Meristematic tissue undergoes mitotic cell divisions and give rise to permanent tissue. On the basis of location meristematic tissue may be:

(a) **Apical meristem** e.g. root tip and stem tip.

(b) **Lateral meristem** e.g. axillary buds which give rise to lateral branches and camibium which give rise to secondary growth (add to thickness).

Some Important Plant Tissues

S. No.	*Tissues*	*Distribution in plant body*	*Structure*	*Functions*
1.	Meristematic	At the tip of root and stem. In vascular bundles secondary meristem, known as cambium.	The cells of meristem are living and parenchymatous.	Actively divide to give new cells to the plant body. Thus, cause increase of growth of plant in length and girth.
2.	Parenchyma	In soft parts of the plant body i.e., cortex, among xylem and pholem tissues and pith.	Its cells are living, thin walled, isodiametric (equally expanded on all sides) may be oval or spherical.	Main function is storage of food. They form the ground tissue.
3.	Collenchyma	Below epidermis in dicot stem and petioles.	Corners or intercellular space of the cells are thickened with the deposition of cellulose and pectin. The cells are living. Sometimes they may contain chloroplasts. Absent in roots and monocot plants.	To provide mechanical support to herbaceous plants.
4.	Chlorenchyma	Outer region of herbaceous stem, green leaves—mesophyll (pallisade & spongy cells).	Cells are similar to parenchyma to cells except they contain chloroplasts in abundance.	To manufacture food material in presence of sunlight.
5.	Sclerenchyma	In cortex, pericycle, and in vascular bundle sheath is associated with xylem and pholem.	Long, narrow, thick-walled dead cells. They are lignified and fibre like or isodiametric cells with thick lignified wall.	They provide mechanical support to the plant.

S. No.	Tissues	Distribution in plant body	Structure	Function
6.	Xylem	Vascular bundles of stem, root and leaves.	Consists of 4 types of cells—vessels, tracheid, wood fibre and xylem parenchyma.	(a) Conduction of water and minerals from roots to different parts of plants. (b) To provide mechanical support as wood.
7.	Phloem	Do	Consists of various types of cells such as companion cells, sieve tubes, phloem parenchyma and phloem fibres.	Conduction of prepared food material from leaves to different parts of plant body.

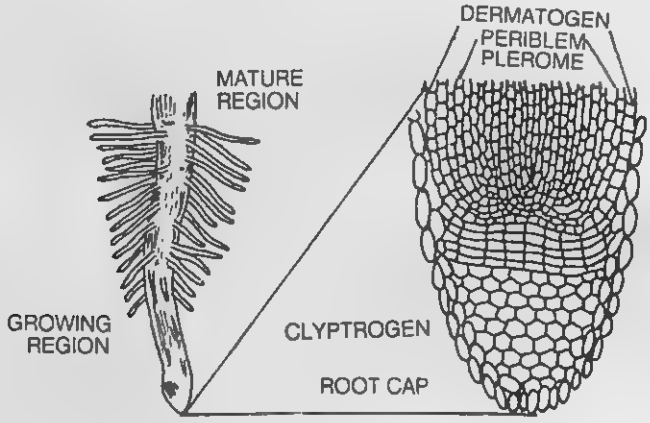


Fig. 18·10 : L.S. of root tip showing meristematic tissue

ORAL QUESTIONS

Q. 1. *What precautions should be taken for cutting a good transverse section ?*

Ans. (i) The material should be fixed in the pith.

(ii) The pith should be kept in the horizontal plane.

(iii) Sections should be cut instantly so that with one jerk the razor or blade cuts the section smoothly.

(iv) Cut sections should be placed in water.

(v) Good sections should be selected and broken or oblique sections should be rejected.

Q. 2. *Which stain will you select for staining the dead tissues of the section ?*

Ans. Saffranin.

Q. 3. *What will you do if the section is over-stained ?*

Ans . Overstaining can be removed by washing the section in acid water. After washing in acid water, the section must be washed thoroughly by water.

Q. 4. *Give two points of identification of dicot stem section.*

Ans . In dicot stem—(i) Hypodermis is collenchymatous, and (ii) Vascular bundles conjoint, collateral and open. Vascular bundles are arranged in ring or rings.

□□

CORE EXPERIMENT 19 (A)

OPENING AND CLOSING OF STOMATA AND TRANSPIRATION

(A) STUDY OF STOMATA THROUGH TEMPORARY SLIDE PREPARATION AND EFFECT OF LIGHT, DARKNESS, KCl AND DEHYDRATION ON THEIR OPENING AND CLOSING. MEASUREMENT OF STOMATAL APERTURE.

(B) STUDY OF THE RATE OF TRANSPIRATION THROUGH THE UPPER AND LOWER SURFACE METHOD IN RELATION TO STOMATAL COUNT.

Aim : To study the stomata through temporary slide preparation and effect of light, darkness, KCl and dehydration on their opening and closing. To know the technique of measurement of stomatal aperture.

Introduction

A stoma is an aperture present in the epidermis of the leaf. Each stoma is surrounded by guard cells. Stomata regulate exchange of gases and loss of water vapour through transpiration from the leaves. When guard cells are turgid, stomata remain open. When the guard cells lose water the stomatal opening becomes smaller, as the thick walls of the guard cells come closer.

The changes in turgor pressure of guard cells that open and close stomatal opening result from the absorption and loss of potassium ions (K^+).

Transpiration mainly occurs through stomata. Stomata remain open during day and close at night. Hence, rate of transpiration is much higher during day than at night. Other factors like temperature, light, air pressure and humidity in the air also affect the opening and closing of stomata.

EXPERIMENT 1

To study the stomata through temporary slide preparation and to know the effect of light, darkness, dehydration and KCl on their opening and closing.

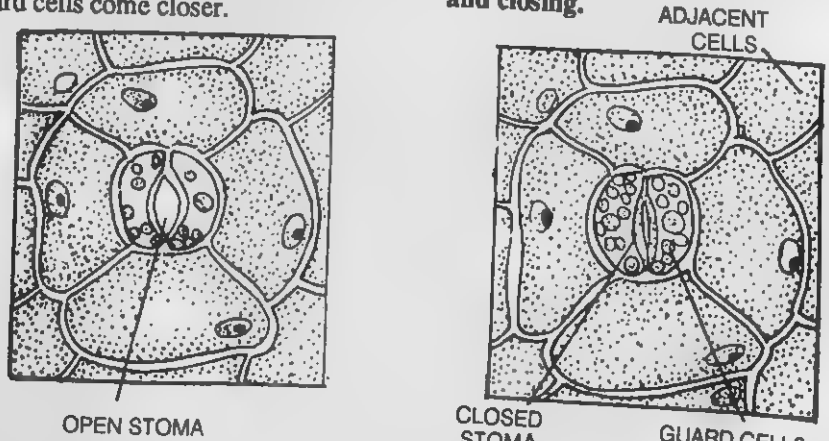


Fig. 19·1 : Structure of a stoma
A - open, B - closed

Material Required

1. Two potted plants - *Balsam* in summer, *Dalhia* in winter or *Zebrina* leaves or *Tradescantia.*
2. Microscope
3. Watchglasses or petridishes
4. Slides, coverslips
5. Forceps, needles, brush
6. Dropper
7. Filter paper
8. Dark chamber
9. 10% KCl solution or Glucose solution
10. Heath's reagent

A. Effect of Light on Stomata

Procedure

To obtain leaf peal, hold the undersurface of balsam or *Tradescantia* leaf upwards. Moisten the leaf in water. Tear the leaf at an angle briskly. The protion of lower epidermis appears as a narrow colourless border along the torn edge. Place the peal in the drop of health's reagent or water on a clean glass silde. Cover with a coverslip and observe under high magnification of microscope. Draw a labelled diagram. Study the structure of a stoma exposed to light.

Now remove a leaf of th same size from the pot which is kept in dark chan.ber for more than 12 hours. Prepare the leaf peel and mount in a drop of water and study the structure of stomata and stomatal aperture. Draw a labelled diagram.

B. Effect of dehydration on the opening and closing of stomata

Procedure

Prepare an epidermal peel slide in water as above. Place hypertonic solution of 10% NaCl or 10% glucose drop by drop on the edge of coverslip and drain out water from the other side with the help of filter paper.

Observation

Observe structure of stomata after it has been flooded with hypertonic solution under the microscope after an interval of three minutes. Draw the diagram. The stomata closes immediately.

C. Effect of KCl on opening and closing of stomata

To study the effect of 10% KCl you may use the leaf peel as obtained for the first time or you prepare a fresh mount. Study the behaviour of stomata. Place a drop of hypertonic solution (10% KCl) from one side, and draw the water out from the other side with the help of filter paper.

Observe the slide immediately under the microscope. Again at the interval of 2 minutes observe. Draw the diagram.

Observation

The beahviour of stomata changes with exposure to light and darkness. When placed in a hypertonic solution the stomata close at once.

Conclusion

Stomatal openings are regulated diurnally. A hypertonic solution causes plasmolysis, hence the inner walls of guard cells become flaccid. The phenomenon is reversible if treated with fresh water but on keeping for a longer duration in the hypertonic solution complete plasmolysis takes place.

Precautions

To protect from exposure to the light the pot should be placed in dark chamber or in a corner of the room which is dark enough.

EXPERIMENT 2

Aim : To measure stomatal aperture.

Material Required

Leaf of *Tradescantia* or garden lily, Microscope, slides, coverslips, Heath's reagent, micrometers (ocular stage).

Procedure

Fix one ocular micrometer in the eye piece and the stage micrometer on the stage below the objective. Prepare a leaf epidermal peel slide in water. Observe the slide under microscope. You will find many superimposed divisions. The distance between two thick lines indicates one division and represents 1 micron (μ). Measure the size of stomatal opening. Measure several stomata and calculate the average.

CORE EXPERIMENT 19 (B)

Aim: Study of the rate of transpiration through the upper and lower surface of leaf by cobalt chloride, in relation to stomatal count.

Material Required

A potted dicot plant with dorsiventral leaves well marked.

$CoCl_2$ paper—3% $CoCl_2$ -filter paper dipped into $CoCl_2$ solultion and then dried.

2 microscopic slides — Petridishes

Rubber-bands or clips — Desiccator

forceps, scissors — stop watch

needle, brush, dropper etc.

Procedure

Soak sheets of filter paper in Cobalt chloride solution. Dry these sheets completely by keeping the same in an oven, near a lamp or in desiccator. Cut these sheets into 10 squares of 1 × 1 cm.

Soak sheets of filter paper in the cobalt chloride solution of given standard. Dry these sheets partially on a squeeze board and then in an oven at 40-50° C. After drying, cut these into 10 squares (each square measuring 1 cm × 1 cm) and place them into desiccator to keep them dry.

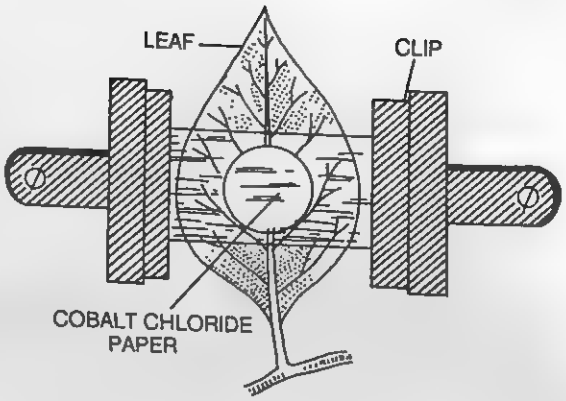


Fig. 19·2 : Cobalt chloride paper experiment.

Quickly remove two cobalt chloride squares from the desiccator and place one on each surface of the leaf. Cover them completely with glass slides. Seal the slides with vaseline and hold the slide in place with the help of rubber bands or use a leaf clasp in place of glass slide to hold the squares.

Observation

Observe the colour change of cobalt chloride paper and note the time taken with the help of stop-watch.

If complete colour change does not take place within 20 minutes, record the transpiration rate as 'negligible'.

S. No.	leaf peel lower surface stomata per unit area	leaf peel upper surface stomata per unit area	leaf peel lower surface time taken to change colour	Average	leaf peel upper surface time taken to change colour	Average
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Take three readings and find the mean time for each surface of the leaf.

Discussion

The distribution of stomata in the two surfaces is unequal. The upper surface is covered by a layer of cuticle. Give your reasons which surface is able to change the colour of cobalt chloride paper earlier.

Precaution

$CoCl_2$ paper should be completely dried. This experiment is not successful during excessive humidity.

ORAL QUESTIONS

Q.1. *What are stomata ?*

Ans. Stomata are apertures in the epidermis of leaf which regulate exhange of gases and loss of water vapours through transpiration from the leaves.

Q.2. *From which surface of the dicot leaf will you take the peel to observe stomata ?*

Ans. Lower surface.

Q.3. *How opening and closing of stomata is controlled ?*

Ans. Change in the turgor pressure of guard cells controls opening and closing of stomata.

Q.4. *What will be effect of dehydration on opening and closing of stomata ?*

Ans. Due to dehydration the guard cells become flacid and stomata are closed to control loss of water from the underlying tissue.

Q.5. *From which surface of monocot leaf you will take the peel to observe stomata ?*

Ans. Monocot leaves are isobilateral hence stomata are present on both the surfaces. Peel can be taken from either surface of monocot leaf.

□□

CORE EXPERIMENT 20
PHOTOSYNTHESIS

STUDY OF THE EFFECTS OF THE CARBON DIOXIDE CONCENTRATION AND LIGHT INTENSITY ON THE RATE OF PHOTOSYNTHESIS.

EXPERIMENT 1

Aim : Study of the effect of carbon dioxide concentration on the rate of photosynthesis using aquatic plant.

Material Required

2-beakers (250 ml.)

Funnel with small stem, a glass rod.

Test tubes 3 and a graduated 10 ml. pipette.

Sodium bicarbonate.

Fresh twigs of Hydrilla.

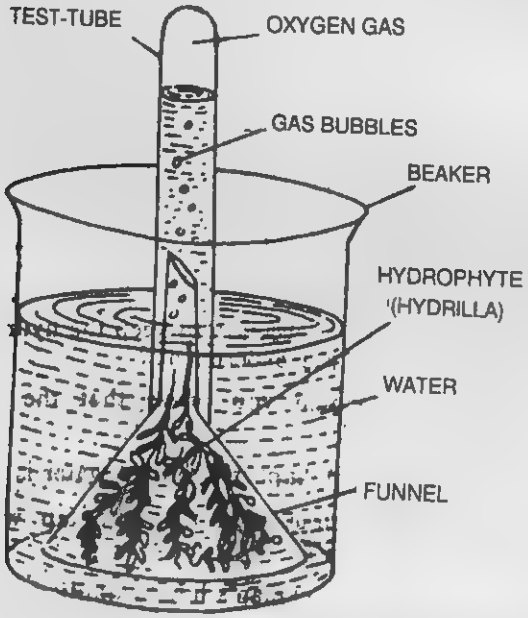


Fig. 20-1 : Evolution of bubbles during photosynthesis

Procedure

Prepare fresh solution of 10% sodium bicarbonate; set the apparatus as shown in diagram using about 150 ml. of tap water. Leave this in sun for some time. When bubbles appear, count the number of bubbles produced in 2 minutes. Add 4 ml. of sodium bicarbonate solution into the beaker and mix with the help of a glass rod. Leave in the sun. Note the number of bubbles produced in 2 minutes. Add 4 ml. of sodium bicarbonate solution again. Note the number of bubbles produced. Repeat this 5 times, till the concentration of sodium bicarbonate solution reaches to 2%. You can take out original water from the beaker (6 ml. every time) so as to maintain the volume of liquid up to 150 ml. Record your data in the table. Plot a graph between number of bubbles evolved and concentration of sodium bicarbonate.

Observation

The rate of evolution of bubbles varies with concentration.

Record your observations as shown in the table on page 152.

Precautions

1. Prepare fresh solution of sodium bicarbonate.

2. In case strong sunlight is not available you may use 100 watt bulbs, maintaining same distance in each experiment.

Table

No. of observations	Sodium bicarbonate in 100 ml. of water	Number of O_2 bubbles evolved per minute			Mean
		I	II	II	
1.	0.0 gm.				
2.	0.4 gm.				
3.	0.8 gm.				
4.	1.2 gm.				
5.	1.6 gm.				
6.	2.00 gm.				

3. The end of the twig should be inserted through the stem of the funnel.

4. Cut the end of the twig fresh.

Graph can be plotted between the concentration of sodium bicarbonate in 100 ml. of water and number of oxygen bubbles per minute.

Discussion

This experiment is meant to verify Blackman's principle of limiting factors. On increasing CO_2 concentration rate of photosynthesis increases till a stage when the number of O_2 bubbles do not increase. This proves, while CO_2 is increased, other environmental factors interfere in the rapidity of photosynthesis.

EXPERIMENT 2

Aim : To study the effect of light intensity on the rate of photosynthesis using aquatic flowering plant *Hydrilla*.

Material Required

Hydrilla Plant, Thermometer, Sodium bicarbonate solution of 1%, Lamp with 100-50 watt bulb, stop watch, Ice cubes, Beakers, Funnels, Test tubes.

Procedure

Set up the apparatus as directed in Experiment 1 and place a lamp 10 cm from the apparatus. Wait till bubbles of oxygen start emerging. Count the bubbles of O_2 evolved per minute. Take three readings. Now move the light back to 14 cm from the apparatus. This would reduce the amount of light reaching the green plant to half, count the bubbles of O_2 per minute.

Reduce the light intensity still more by placing the source of light at a distances of 20 cm and 32 cm from the apparatus respectively. Note down your observations as done in previous experiment for each step. Keep the temperature constant.

Plot a graph with separate curves for each intensity, make a second graph, plotting light intensity on the horizontal axis and rate of O_2 bubbles on the vertical axis. Light intensity varies inversely with the square of the distance from the light sources.

If you let 100% represent the light intensity at 10 cm, then at 14 cm the intensity is 50%, at 20 cm it is 25% and at 32 cm it is 10%. Plot these points on your graph.

Inference : Draw inference on the basis of your observation.

Precautions

(i) Add sodium bicarbonate solution to supply CO_2 but do not add too much of it.

ORAL QUESTIONS

Q. 1. *What is photosynthesis ?*

Ans. Synthesis of simple carbohydrate (glucose) from CO_2 and water in presence of chlorophyll and sunlight.

Q. 2. *What are the main steps of photosynthesis ?*

Ans. The main steps of photosynthesis are—

Q. 3. *From which raw material oxygen comes out during photosynthesis ?*

Ans. Oxygen is produced by photolysis of water.

Q. 4. *Beside food and oxygen what is the other important product formed in photosynthesis ?*

Ans. ATP.

Q. 5. *Why do we add sodium bicarbonate to the water to study evolution of oxygen during photosynthesis ?*

Ans. To provide carbon dioxide.

Q. 6. *Why does photosynthesis not take place in green light ?*

Ans. Green light is not absorbed by the green plants (chlorophyll).

Q. 7. *Which pigments are mainly concerned with photosynthesis ?*

Ans. Chlorophyll 'a' and chlorophyll 'b'.

Q. 8. *Why chlorophyll appears green ?*

Ans. Because chlorophyll reflects green light.

Q. 9. *In which colour the rate of photosynthesis is maximum ?*

Ans. In red coloured light.

□□

CORE EXPERIMENT 21

RESPIRATION

STUDY OF RATE OF AEROBIC RESPIRATION OF FLOWER BUDS/LEAF/ TISSUES/GERMINATING SEEDS

Aim : To measure the rate of aerobic respiration of flower buds/leaf tissue/ germinating seeds.

Material Required

1. 3—Conical flasks or bottles of 250 ml. aspirator.
2. 4—double bore corks.
3. 5—delivery tubes bent at 2 places.
4. 1 pinch cork.
5. Germinating seeds (preferably gram)
6. Conc. KOH solution
7. 0·1N KOH or $Ba(OH)_2$ & 0·1N HCl solution.
8. Burette.
9. phenophthalene
10. young flower buds & leaves etc.
11. paraffin wax or plaster of paris.

Procedure

Set the apparatus as given in Fig. 21.1. Half fill the first flask with conc. KOH solution. Weigh 20 grams of germinating seeds and put them in the 2nd flask. Place 20 ml of 0·1N KOH or Ba $(OH)_2$ solution in the third flask. Attach aspirator to the third flask. Make the whole set up air tight by using plaster of paris or paraffin wax.

Suck the water from aspirator and regulate its flow by a pinch cork. Cover the seeds by a black cloth. After the time limit (about 2 hours) disconnect the aspirator and remove the third flask. Keep a fresh flask containing 20 ml. of 0.1 N KOH to replace flask C and allow the seeds to respire and connect with the aspirator. Allow for 2 hours again. Repeat third time also.

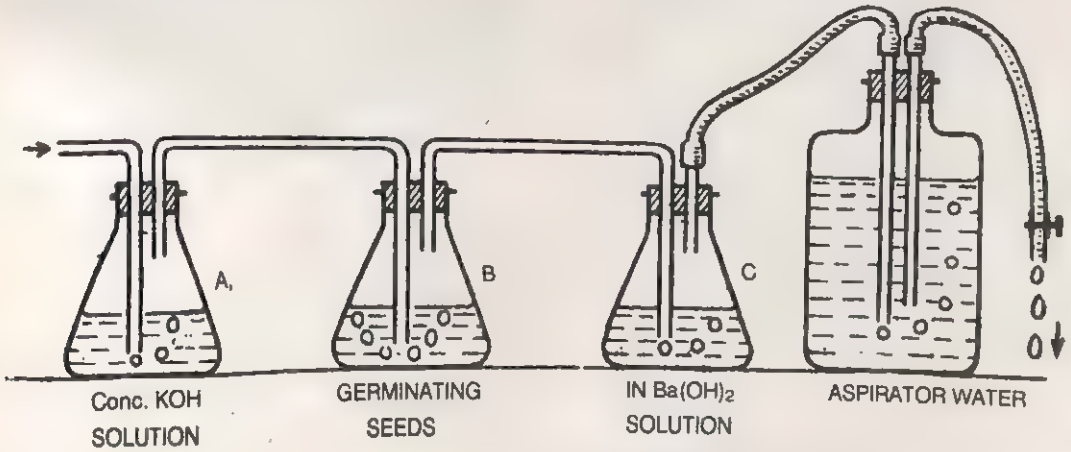


Fig. 21.1. Experiment to measure the rate of aerobic respiration.

No.	Burette reading		Difference in ml. D	Average of 3 titrations	Vol. of KOH used by CO_2 released during germination (respiration) 20 D = Vol. of alkali used.
	Initial	Final			
1. 2. 3.					

Meanwhile, fill in 0.1 N HCl in the burette and titrate till the end point with the solution in flask C. Similarly repeat for the third flask. Note your readings in the table as given above.

Observation

Stream of air passing through the flasks is seen by the bubbling.

Discussion

The air passing from flask A gets free from CO_2, since KOH in flask A absorbs this gas. Due to respiration oxygen is taken in and carbon dioxide is released. While passing through flask C, the carbon dioxide is absorbed in KOH of known concentration. The titration shows unutilized KOH in terms of 0.1 N HCl volume which has been in excess and has not been utilized by CO_2 evolved during two hours duration of respiring seeds.

To know the actual amount of CO_2 produced in terms of weight, apply the following formula—

$$CO_2 \text{ evolved in mg/gm/hour} = \frac{\text{Vol. of 0·1 N KOH used during respiration} \times \text{normality of HCl} \times 22}{\text{time in hours} \times \text{weight of respiring material in gms.}}$$

where, 22 is the gm. equivalent weight of CO_2.

Similarly you can find the rate of respiration of other substrates such as germinating seeds, buds and leaves.

Precaution

Cover flask B with a black paper if green leaves are used as respiring substrate. Photosynthesis interferes with the respiration. Why?

The same experiment can be repeated with freshly plucked flower buds or leaves.

□□

CORE EXPERIMENT 22

WATER POTENTIAL OF PLANT TISSUES

MEASUREMENT OF WATER POTENTIAL OF TISSUE OR DIFFUSION PRESSURE DEFICIT (DPD)

Aim : To measure diffusion pressure deficit of plant tissues (DPD).

Theory

Water Potential or Diffusion Pressure Deficit

Each solvent in its pure form has a specific diffusion pressure. When a solute is added to the solvent its diffusion pressure lowers down. *The amount by which diffusion pressure of a solution is lower than of its solvent is called diffusion pressure deficit or water potential.*

DPD = OP – TP/WP

Water potential =

Osmotic Pressure – Turgor Pressure

Turgor Pressure (Hydrostatic Pressure, TP): The pressure exerted by the cytopolasm on the cell wall is called turgor pressure. It increases due to entry of water molecules into the cell. Turgor pressure is equivalent of wall pressure which is exerted by the cell wall on the cytoplasm.

Osmotic Pressure (OP)

Osmotic pressure is the pressure which develops in a solution when it is separated from a pure solvent by a semipermeable membrane to countermand its diffusion inside or Osmotic pressure is the pressure required to stop osmosis or diffusion of solvent into the solution when the two are separated by a semipermeable membrane that allows movement of solvent but not of solute.

Material Required

1. Two big sized peeled potato tubers.
2. Sugar solution of 10 different concentrations—·1M, ·15M, ·20M, ·25M, ·30M, ·35M, ·40M, ·45M, ·50M, ·55M.
3. 10 beakers of 250 ml.
4. 10 watch glasses
5. Balance & weight box
6. Blotting paper
7. Forceps
8. Cork-borer
9. A small tray to keep beakers
10. Methylene blue
11. Test tubes
12. Dropper
13. Cork borer.

Procedure : Prepare 10 different concentrations of sugar solution and keep the equal amount in 10 beakers. Label them by a glass pencil. Scoop out cylindrical pieces of potato tuber by cork borer of same size. Keep them in water. Cut them into 2.5 cm length by a sharp blade. Select 3 pieces of these cylinders and wipe them by blotting paper. Do not press or squeeze. Weigh these pieces and place them in one beaker. Note the weight of cylinders in a tabular form as given in the table for all concentrations. Cover the beakers with watch glasses and place them in a tray. Keep the tray in a cool, dry and preferably dark place.

Next day, collect the tubers from beakers one by one and wipe them. Take their weight and note the reading. Repeat for all the ten beakers. Plot a

S. No.	Sucrose Solution molar conc.	Sucrose mix/litre	Osmotic potential Atm. at 20°C	Fresh wt. of cylinders	Final wt. of cylinders	Change in weight
1.	0·15M	51·3 gms	—4·0			
2.	0·20M	68.4 gms	—5·3			
3.	0·25M	85·5 gms	—6·7			
4.	0·30M	102·6 gms	—8·1			
5.	0·35M	119·7 gms	—9·6			
6.	0·40M	136·8 gms	—11·6			
7.	0·45M	153·9 gms	—12·7			
8.	0·50M	171·0 gms	—14·3			
9.	0·55M	188·1 gms	—16·00			
10.	0·60M	205·2 gms	—17·00			

graph between change in weight and concentration of sugar solution.

Observations

You will note the difference between original and final weights except one where it remains same in that concentration.

Discussion

Potato tubers when placed in different sugar concentrations, movement of solvent molecules (water) takes place in or out of living tissue. Hence

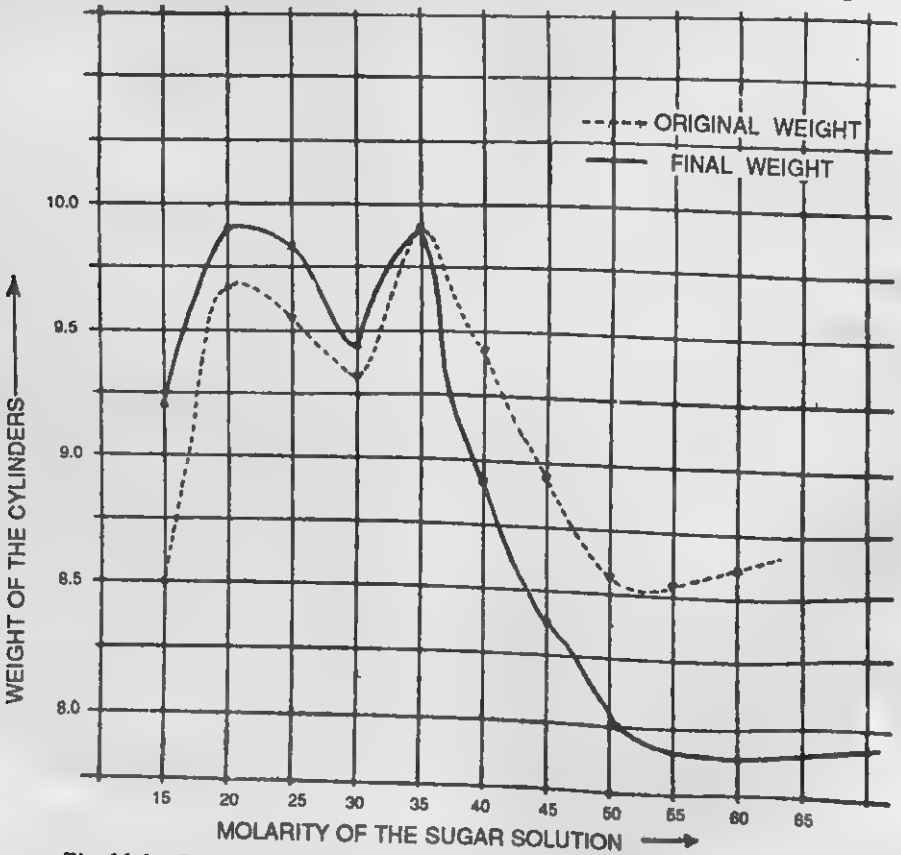


Fig. 22·1 : Graph showing water potential of potato tuber by weight method.

there is change in weight. The weight remains constant at one concentration. This means as equilibrium has reached between water potential of the tissue and osmotic potential of that sugar solution. From this experiment we can conclude that diffusion pressure deficit reaches zero when osmotic pressure of the solution is equal to water potential;hence DPD = 0

Water potential (DPD = OP – TP) or (= 0)

Conclusion

The water potential of potato tuber is equal to the osmotic potential of sugar solution—molarity, in which there is no movement of drop of water into or out of the tissue.

Note : This experiment needs 2 days' work and can be carried out in a team. If you want to complete the experiment on the same day, you will have to begin in the morning and an interval of atleast 6 hours is required to take the final weights.

ORAL QUESTIONS

Q. 1. *What is osmosis ?*

Ans. The diffusion of water molecules from the solution of lower concentration of solute (dilute solution) to the solution of higher concentration of solute (concentrated solution) through a semipermeable membrane is called osmosis.

Q. 2. *What is osmotic pressure ?*

Ans. Actual pressure which develops in a solution when it is separated by a semipermeable membrane from solvent (or pure water) of which solution has been made; or the pressure required to stop the osmosis when a solution is separated by a semipermeable membrane from pure water or solvent at room temperature (20°C).

Q. 3. *In which units osmotic pressure is measured ?*

Ans. Osmotic pressure is measured in atmospheres or in bars (1atm = 1.01 bars).

Q. 4. *What is the difference between osmotic pressure and osmotic potential ?*

Ans. Osmotic pressure is the actual pressure which develops in a solution when it is separated from pure water by a semipermeable membrane. Osmotic potential is the change in free energy of the solvent molecules when a solute is added to it. Osmotic potential (p) is numerically equivalent to the osmotic pressure but is given a negative sign because it is not a real pressure.

Q. 5. *What is the relation among diffusion pressure deficit (DPD), osmotic pressure (OP) and turgor pressure (OT) in a fully turgid cell ?*

Ans. In a full turgid cell, pressure deficit is equal to osmotic pressure.

□□

CORE EXPERIMENT 23

CHROMATOGRAPHY

APPLICATION OF PAPER CHROMATOGRAPHY FOR THE SEPARATION OF PLANT PIGMENTS

Aim : To apply paper chromatography for the separation of plant pigment.

Chromatography

(*Chroma—Colour + Graph - writing*)

Chromatography is basically a technique of isolating molecules or components of an organic macromolecule like amino acids of proteins or different proteins, pigments or even the nucleic acids and their nucleosides. The isolation is based on differential rate at which compounds in a solution migrate across a adorsbent surface.

Types of Chromatography

1. Column chromatography
2. Paper chromatography
3. Ion exchange chromatography

EXPERIMENT 1

Aim : To separate plant pigment (chlorophyll) from leaves by paper chromatography. Paper chromatography is a method of analysing mixtures of compounds, depending upon the different rates at which compounds in solution will migrate across a sheet of porous paper specially prepared with indicators.

Material Required

1. Green spinach leaves
2. Acetone
3. Solvent acetone, petroleum ether in proportion of 92 : 8 respectively.
4. Fine sand.
5. Longer test tubes, test tube stand, pipette with fine tip or preferably a capillary tube. Funnel, funnel stand.
6. Paper clip, pestle-mortar.
7. Filter paper (Whatman No. 1).
8. Pencils.

Procedure

Prepare chromatographic strip by cutting the Whatman filter paper lengthwise and slightly less then the diameter of the test tube. The length of the strip should be such that the point of the strip should never touch the bottom of the test tube. Cut two notches at a distance of about 1 cm. from the edges as shown in Fig. 23.1, and mark a circle with a pencil at the centre of the notch. Prepare solvent by adding 8 ml. of acetone into 92 ml. petroleum ether. Mix well. Pour the solvent in the test tube upto the height of 1.2 cms. Cover this with a cork and let the fumes saturate the atmosphere inside the test tube.

Grind few fresh green leaves along with a small amount of sand to a paste. Add to this few ml of acetone. The chlorophyll will get mixed. Decant the same into a test tube either by filtration or allow the mixture to settle in the test tube for 5-10 minutes. Cover the test tube with a cork since acetone is volatile.

Place a drop of the mixture on the mark of the notch of the filter paper by the help of a fine pipette or a capillary tube. Allow the drop to dry. Never

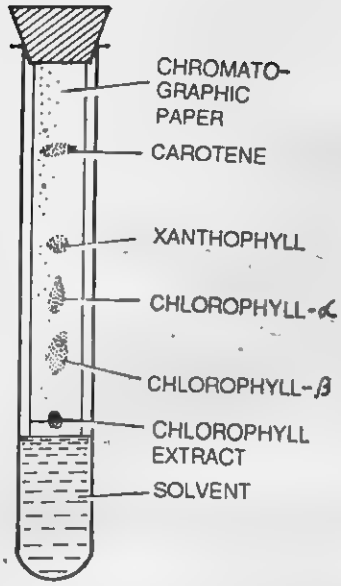


Fig. 23·1 : Chromatography (linear)

keep the strip on the table, since acetone may dissolve other impurities also from the table. Let the paper strip be placed in an inclined plane so that the notch is hanging in the air or you can place the notch between two pencils. Place another drop of the extract at the same place and dry. Repeat for four times and allow the drop to dry completely. Hang the paper strip in the test tube containing solvent by the help of a common pin bent to form a J shape or fix with a cellotape. Replace the cork and make sure that the apparatus is air tight. Wait for sometime. The solvent will start rising by capillary action. Remove the filter paper strip from the test tube when solvent reaches up to the hook. Dry the strip either by holding or by the hanging on a stand. Mark the last point on the filter paper where solvent has reached. On drying you will find 4 different coloured zones, indicating four components of chlorophyll. This is a chromatogram.

Observation

Lowest band is yellowish in colour which shows the presence of chlorophyll-*b*. The next higher up band is bluish green in colour which is formed due to the presence of chlorophyll-*a*. The next higher (third one) yellow in colour is due to presence of xanthophyll. The top-most band is seen at a distance from the other three and this is orange yellow in colour. This shows the presence of carotene.

Conclusion

The green leaves contain four types of pigments namely *chlorophyll b, chlorophyll a, xanthophyll* and *carotene.*

EXPERIMENT 2

Aim : To separate and examine the pigments present in green leaves by circular chromatography method.

Material

Same as in previous experiment. Here you will need a pair of petridishes instead of test tube and circular filter paper in place of long strips.

Procedure

Prepare chlorophyll extract as mentioned in the previous experiment. Select the size of filter paper slightly bigger than the diameter of the petridishes. Mark a small circle in the centre of the filter paper with the help of a pencil. Draw two parallel lines on one side of the circle. Cut a small strip beginning from outer side to the centre. *Do not detach* the tip from the filter paper. Put 4 drops of chlorophyll extract in the centre one by one as done previously and let it dry. Take solvent in the petridish sufficient to cover the bottom and place the filter paper, so that the folded strip dips into the solvent. The solvent will rise through this strip and spread in a circular manner. Now cover the filter paper with 2nd petridish.

Wait till the solvent spreads over the edges of the filter paper. Remove and dry by hanging on a stand (Fig. 23.2).

Observation

You will observe four circular bands of different pigments in order of the vertical paper chromatogram. The sequence has chlorophyll *b*, chlorophyll *a*, xanthophyll and carotene.

Conclusion

Chlorophyll contains four pigments—chl. *b*, chl. *a*, xanthophyll and carotene in the green tissues of the plants.

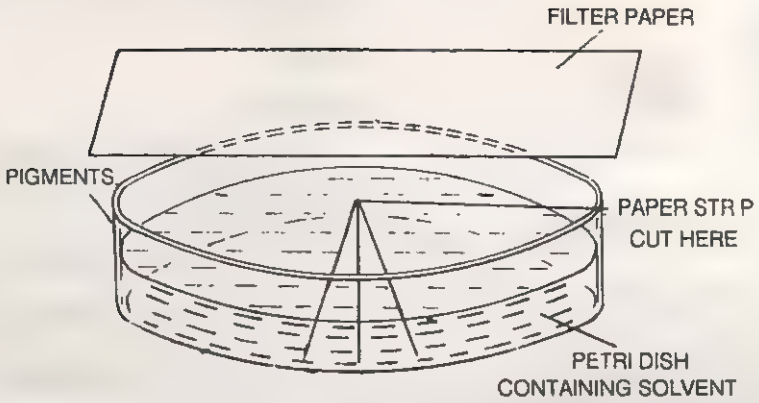


Fig. 23-2 : Circular Chromatography .

Precautions

Do not hold the chromatography paper by hand. Hold it always by a forceps otherwise marks of amino acids from your skin will also appear on the chromatogram and hinder better results.

ORAL QUESTIONS

Q. 1. *What is chromatography ?*

Ans . Chromatography is the technique by which all kinds of coloured and colourless components of a solution can be separated.

Q. 2. *Who was the discoverer of chromatography technique ?*

Ans . Russian botanist, Michael Tswell (1906).

Q. 3. *What will be the position of chlorophyll a, chlorophyll b, carotene and xanthophyll in a vertical paper chromatogram of green leaves ?*

Ans . In a vertical paper chromatogram of green leaves, the lowest band shows the presence of chlorophyll *b*, next higher up band is due to chlorophyll *a*, the third higher band is of xanthophyll and the top-most shows the presence of carotene.

Q. 4. *What would be the colour of bands of chlorophyll b, chlorophyll a, xanthophyll and carotene in a paper chromatogram ?*

Ans . In a paper chromatogram colours of bands of pigments will be:

chlorophyll *b*—yellowish green.

chlorophyll *a*—bluish green.

xanthophyll—yellow.

carotene—orange yellow.

Q. 5. *What is chromatogram ?*

Ans. A chromatogram is the developed record of chromatography produced in paper chromatography, thin ledger chromatography or gas chromatography. It gives location of different constituents of a substance.

□□

INVESTIGATORY PROJECT 1

STUDY OF CELL

PREPARATION OF A THREE DIMENSIONAL MODEL OF A PLANT OR ANIMAL CELL

Aim : To prepare a three dimensional model of an animal or plant cell so as to study its cell organelle, their relative size and location in the cell.

Theory : What is a cell ?

1. Cell is the basic structural and functional unit of all living beings.

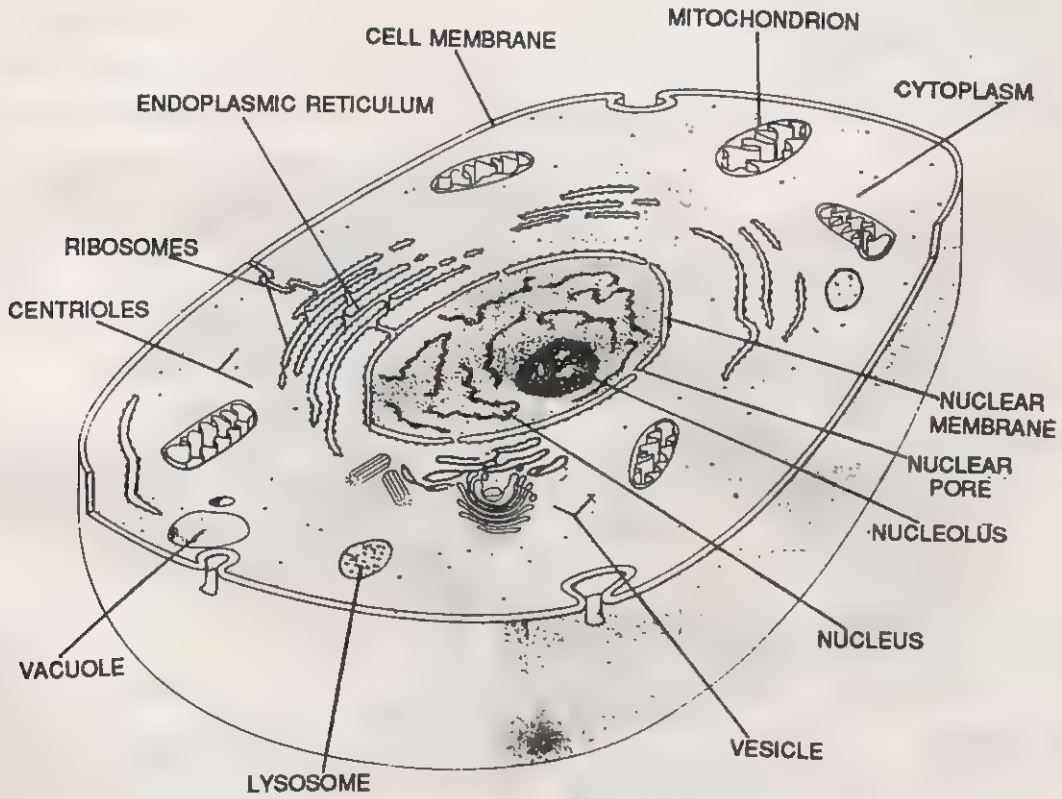


Fig. 1-1 : (A) Three-dimensional view of an animal cell.

2. Each cell is a tiny microscopic box of protoplasm.

3. It contains a nucleus, cell organelle, cytoplasm and vacuole.

PREPARATION OF MODEL

Material Required

Several methods and a variety of materials can be used for preparing cell model. Some of them can be:

1. Cardboard box, bangles, nylon threads, pulses, grains, sketch pens of different colours, water colours and brushes. Gum or favicol or some other adhesive.

2. Clay, paints and other related materials for colouring.

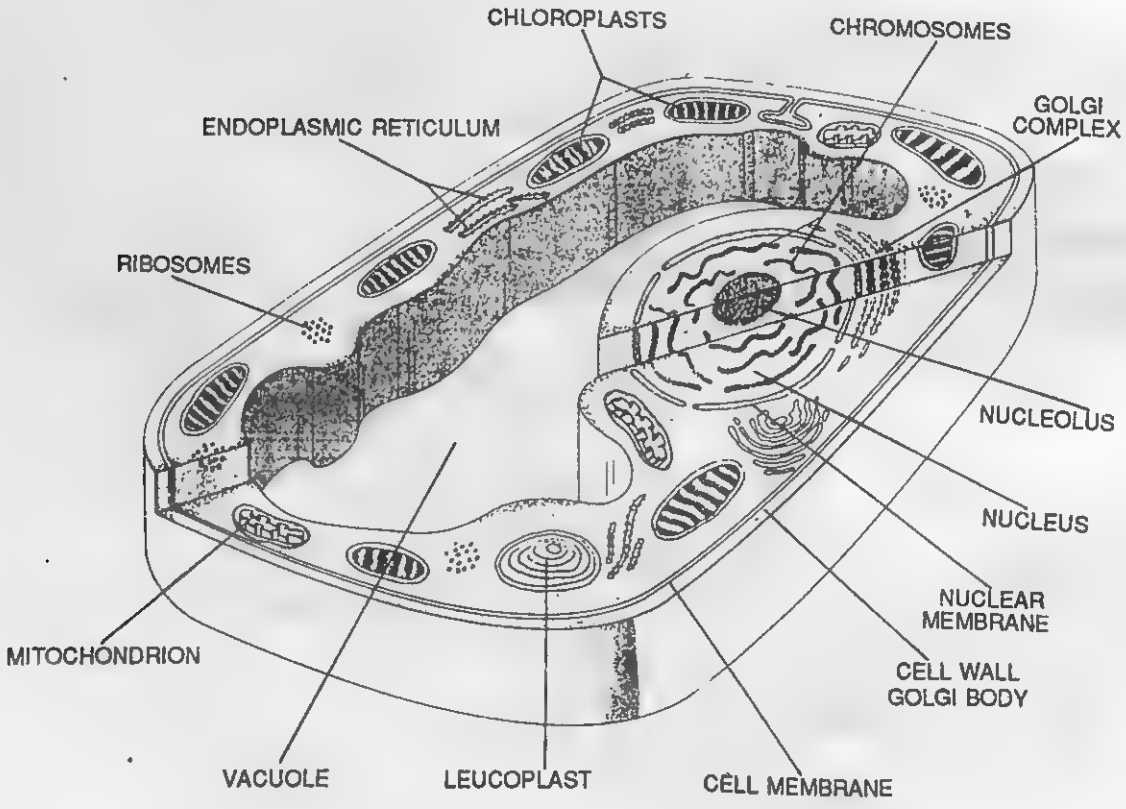
3. Plastic plates, nylon threads, beads and other materials as mentioned in sr. no.1.

4. Plastecene of different colours.

PREPARATION OF THERMOCOL MODEL

Material Required

Thermocol sheet or plywood, threads, quickfix or favicol, poster colours, ribbons of different



1·1 : (B) Three dimensional view of a plant cell.

colours, beads etc., scissors, blade, pencil, eraser, scale, reference book.

Procedure

With the help of thermocol sheets or plywood and threads or any other material, prepare a model of an animal or plant cell as shown in Fig. 1.1. Use different colours to represent different cell organelle. Thread or cords can be used to represent plasma membrane and endoplasmic reticulum.

Students can use any material of their own choice to represent the structure in the best possible manner. Try to label the model.

2. Plastecene Model : With the help of differently coloured plastecene prepare different organelle of cell. Mount them on a cardboard sheet or plastic plate.

3. Plastic Sheet Model

Material Required

(i) 5 square plastic sheets of equal size.

(ii) 2 pentagonal (five sided) plastic sheets of equal size.

(iii) Bangles of different sizes and of different colours.

(iv) Plastic rope cut into small pieces.

STRUCTURE OF CELL

CELL WALL

The **cell wall** is present in plant cells. It is absent in animal cells. It mainly consists of cellulose, hemicellulose, lignins, fatty substances like waxes and pectin compounds are also found in the cell wall. The cellulose fibres form a microfibrillar network embedded in a gel-like matrix.

The cell wall is made up of (*i*) a middle lamella, (*ii*) a **primary wall** on each side of the middle lamella and (*iii*) in many cells a **secondary wall** on the inner side of the primary wall.

The **middle lamella** is the cementing layer between the primary walls of the adjacent cells. The wall produced immediately after the division of the cell constitutes the **primary cell wall.** In several kinds of cells, **primary wall** is the only kind of cell wall present, as in **parenchyma, collenchyma, cambium, etc.** It consists of cellulose, hemicelluiose and pectin. In some cells, like **xylem fibres, scleroblast cells,** a secondary wall is formed at a later stage. It usually has lignin in addition to cellulose.

Functions

1. Cell wall is protective and provides mchanical support to the cell.

2. It provides a definite shape to the cell.

3. It prevents the cell from desiccation.

CELL MEMBRANE

The **cell membrane,** also called the **plasma membrane** or **plasma lemma** is present as an outer envelope surrounding the protoplasm. In plant cells, it is present on the inner side of the cell wall. It exhibits a **trilamellar** (unit membrane) structure. It is composed of two layers of protein molecules between which is a double layer of phospholipids.

Functions

1. The plasma membrane is **selectively permeable.** It permits only certain substances to pass through it but not others.

2. It protects the internal structure and also helps in maintaining the internal environment of the cell.

3. Various cell organelle such as mitochondria, chloroplasts, endoplasmic reticulum are also bounded by membranes similar to the plasma membrane.

CYTOPLASM

All the components of a cell internal to the cell membrane constitute **protoplasm.** The portion of protoplasm without the nucleus is called **cytoplasm.**

Cytoplasm is a viscous, transluscent jelly-like substance filling almost the whole of the interior of the cell. In the cytoplasm, food materials are stored, and a number of chemical reactions take place resulting in the building up of materials and supplying of energy for the cellular activities. Thesse reactions take place in small bodies embedded in the cytoplasm. These are known as cell organelle.

CELL ORGANELLE

The various cell organelle are—

1. Endoplasmic Reticulum (ER)

The cytoplasm is traversed by an intricate system of tubular structures forming the **endoplasmic reticulum.** At places the network is connected with the plasma membrane and the nuclear membrane. The tubules of ER are lined by membrane resembling plasma membrane. Tiny granules, the **ribosomes**, are attached to the extranal surface of some membranes. These membranes are termed **rough membranes.** The membranes without ribosomes are known as **smooth membranes.**

Functions

(1) The ER is said to act as a channel for the transport of various metabolites within and between the cells.

(2) It provides an increased surface area for various biochemical reactions.

(3) It takes part in the formation of other membrane bound structures of the cell, like chloroplasts, mitochondria and Golgi complex.

(4) It also provides supplementry mechanical support to the cell matrix.

2. Ribosomes

These are minute granular or spherical structures. They contain ribonucleic acid and protein. They are either attached to the ER or dispersed freely in the cytoplasm.

Function. The ribosomes are concerned with the synthesis of proteins from amino acids.

3. Golgi Bodies

Golgi bodies are considered as special portions of ER specialized for cell secretion. These were first discovered by **Camilo Golgi** and named **Golgi complex** or **Golgi bodies.** Each Golgi body consists of several flattened, bag-like structures called cisternae. These are arranged one above the other like a number of saucers of watchglasses. Numerous vesicles arise from the edges of Golgi cisternae. In plant cells, the Golgi complex consists of several interconnected subunits called **dictyosomes.**

Functions

(1) The main function of Golgi complex is secretory. It secretes polysaccharides, proteins, enzymes and lipids. The secretory vesicles budded off from the edges contain the secretory products.

(2) In plant cells Golgi bodies are involved in the formation of cell wall.

(3) Golgi complex rorms acrosome in sperms and helps in dissolving the egg-membrane at the time of fertilization.

4. Lysosomes

Lysosomes are spherical and sac-like bodies bounded by a single membrane. These contain several digestive enzymes which when released bring about the breakdown of various cytoplasmic structures. If these enzymes are released freely in the cell, they would result in the **autodigestion** of the cell itself. Therefore, they are referred as the **suicide bags** of the cell. The lysosomes are not found in plant cells.

Functions

(1) Lysosomes protect the body from the bacteria and viruses.

(2) They remove and destory the old worn out cell organelle.

(3) They provide energy by controlled break down of stored food substances.

5. Mitochondria

A mitochondrion is a double walled, spherical or rod-like structure. It consists of an **outer** and an **inner membrane** and enclosed within them are two spaces or chambers.

The **outer** membrane is **smooth**, but the **inner** membrane is folded into finger-like projections, the **cristae.** Between the outer and the inner membranes is the **intermembranous space** or **outer chamber.** The space enclosed within the inner membrane is inner chamber. It is filled with a homogeneous **mitochondrial matrix.** The inner membranes, and the cristae bear stalked

F_1 particles. The outer and inner membranes, the intermembranous space and the matrix contain respiratory enzymes required during the oxidation of foodstuffs to release energy (Krebs cycle).

Function. Inside the mitochondria occurs the oxidation of foodstuffs to release energy in the form of ATP. For this reason mitochondria are called **'power houses'** of the cell.

6. Plastids

These are found only in plant cells. They are basically of two types—coloured (**chromoplasts**) and colourless (**leucoplasts**). The green coloured chromoplasts are especially designated as **chloroplasts.**

1. Chloroplasts. These are plastids that contain green pigment, the **chlorophyll,** found only in the green parts of the plants.

The chloroplasts are bounded by two membranes. The **stroma** or the **matrix** fills the inner space of the chloroplast. It contains starch grains, minute granules and osmophilic or lipid droplets.

In the stroma are found several double-membraned **lamellae** extending from one end of the plastid to the other end. At places the lamellae pile up one above the other like piles of a saucer to form a functional unit called **granum** (plural grana). The grana are interconnected by lamellae called stroma lamellae. The grana contain chlorophyll and other photosynthetic pigments to trap the light energy.

Function. The chloroplasts are the kitchen of the cell. They synthesize carbohydrates from carbon dioxide and water by the process of photosynthesis.

2. Chromoplasts. These contain pigments other than the green. These impart varied colour effects to flowers and fruits, *e.g.*, petals of flowers, carrots tomatoes and red chillies.

Function. These attract insects and other animals to ensure pollination and dispersal of fruits

3. Leucoplasts. These are colourless plastids found in the storage organs of plants such as potato, carrot and seeds.

Function. These store starch, proteins lipids or oils.

7. Nucleus

Nucleus is the controlling centre of the cell. It may be oval or spherical, but in some cases it may be elongated or lobed. The nucleus is bounded by two layered **nuclear membrane** that is often continuous with the ER. The nucleus contains the gelatinous **nuclear sap** or **karyolymph** or the **nucleoplasm.** Within the nucleoplasm is present the **chromatin material.** The chromatin is composed of deoxyribonucleic acid (DNA) and proteins. During cell division, chromatin occurs as distinct threads, the **chromosomes.** DNA is the hereditary material. It determines the characteristics of an organism and transmits them from generation to generation.

Function. Nucleus serves as the controlling centre of all the activities of a cell.

Nucleolus. Inside the nucleus lies a denser body (or more than one) known as **nucleolus.** It contains large amount of **ribonucleic acid** (RNA) and proteins used in the formation of ribosomes.

The nucleolus and nuclear membrane disappear during cell division and reappear at the end of it.

8. Centrosome

Centrosome is not present in plant cells. In animal cells it is present near the external surface of the nucleus as a small hyaline body.

The centrosome consists of two cylindrical bodies, the **centrioles.** These are placed at right angles to each other and are non-membranous. There are nine sets of tubules arranged in a ring. Each set has three **subtubules.** These are connected with each other and with the central rib by means of fine strands called spokes.

Functions

(1) Centrioles play an important role in the formation of spindle and therefore, in cell division.

(2) These form basal bodies of cilia and flagella.

9. Cilia and Flagella

Cilia and flagella are motile, hair-like structures found on the free surface of the cells. These create

water current, food current, act as sensory organs or propel a cell through a liquid medium.

Cilia are short and numerous, while flagella are long and few.

Both cilia and flagella originate from the basal bodies in the cytoplasm, and have the same identical structure.

10. Vacuole

Vacuoles are a prominent feature of plant cells but these are also found in animal cells.

A vacuole is a hollow space in the cytoplasm, bounded by a delicate cytoplasmic membrane, the **tonoplast,** and is filled with **cell sap.** The cell sap contains minerals, sugars, amino acids and waste products dissolved in water.

In fresh water and some parasitic protozoans, there are special types of vacuoles for the elimination of excess of water that enters their body by osmosis. Since water is forced out through cell membrane by the contraction of the vacuoles, these are known as **contractile vacuoles.**

Functions. Vacuoles maintain turgidity in plant cells and store food material and waste products. In protozoa they help in maintaining water balance.

ORAL QUESTIONS

Q. 1. *What is the outermost covering around plant cells but not in the animal cells ?*

Ans . Cell wall is found in plant cells but not in animal cells.

Q. 2. *Give differences between plant and animal cells.*

Ans . Differences between a Plant Cell and an Animal Cell

Plant Cell	*Animal Cell*
1. Cell wall is present outer to the cell membrane.	1. Cell wall is absent.
2. Chloroplasts are present.	2. Absent.
3. In young plant cells several small vacuoles may be present but mature plant cells may possess a large central vacuole.	3. Vacuoles are absent in animal cells. When present they are very small in size.
4. Golgi bodies are represented by dictyosomes.	4. Golgi bodies are present.
5. Centrioles absent.	5. Centrioles present.

Q. 3. *What is power house of cell ?*

Ans . Mitochondria.

Q. 4. *What is the function of lysosome ?*

Ans . Lysosomes are tissue dissolving bodies. These are called 'suicide bags.'

Q. 5. *Name of cell organelle that performs photosynthesis ?*

Ans . Chloroplasts are associated with photosynthesis.

Q. 6. *Who discovered nucleus ?*

Ans . Robert Brown.

Q. 7. *Who discovered cell ?*

Ans . Robert Hooke.

Q. 8. *Name the organelle present exclusively in plant cells.*

Ans . Cell wall and plastids.

Q. 9. *Name the organelle present exclusively in animal cells.*

Ans . Centrioles.

□□

INVESTIGATORY PROJECT 2

DEOXYRIBONUCLEIC ACID

PREPARATION OF THREE DIMENSIONAL MODEL OF DNA

Aim : To prepare the model of DNA to exhibit three dimensional appearance.

Material Required

A wooden stand	Glaze papers of
Cardboards	different colours, Scissors
Hard wire	Gum or Favicol.

Deoxyribonucleic Acid—DNA

Occurrence : DNA is found in the cells of living organisms except plant viruses, where RNA forms the genetic material and DNA is absent. Inside every eukaryotic cell DNA is chiefly concentrated in the nucleus and constitutes nuclear chromatin together with protein. Traces of DNA are found in mitochondria and chloroplasts.

Structure : DNA is a macromolecule of very high molecular weight which may measure to several millions.

Shape : In eukaryotic cells the DNA occurs in the form of long spirally twisted unbranched thread.

Chemical Composition : DNA is composed of three different types of compounds—

(*i*) **Sugar**—It is represented by a pentose—the **dyoxyribose.**

(*ii*) **Phosphoric acid.**

(*iii*) **Nitrogenous bases**—These are nitrogen-containing organic ring compounds. These are four in number and are known as (*i*) adenine (*ii*) thymine (*iii*) cytosine and(*iv*) guanine. These four nitrogenous bases are of two different types :

(*a*) **Purines**—These are two-ringed nitrogen compounds. Adenine and guanine are two purines found in DNA. These are represented by the letters A and G.

(*b*) **Pyrimidines**—Cytosine and thymine are the pyrimidines formed of one ring only. These are represented by the letters C and T.

Molecular Structure (Watson and Crick's model)

In 1953 **D.S. Watson** and **F.H.C. Crick** presented a working model of DNA. The Watson and Crick's model of DNA is not only illustrative of its chemical nature but also of the mechanism by which it duplicates itself.

Nucleotides and nucleosides—A DNA is a macromolecule, being formed of several thousand units of monomers. These units are known as nucleotides. A nucleotide is formed of one molecule of deoxyribose, one molecule of phosphoric acid and one of the four nitrogenous bases. A nitrogenous base with one molecule of deoxyribose constitutes nucleoside. With four nitrogenous bases, there are four types of nucleosides and so four types of nucelotides. The four nucleotides are known as :

1. **Deoxyadenylic acid**—Adenine + Deoxyribose + Phosphoric acid.

2. **Deoxyguanylic acid**—Guanine + Deoxyribose + Phosphoric acid.

3. **Deoxycytidylic acid**—Cytosine + Deoxyribose + Phosphoric acid.

4. **Deoxythymidylic acid**—Thymine + Deoxyribose + Phosphoric acid.

Polynucleotide Chain

In a nucleotide the phosphoric acid molecule is attached to deoxyribose molecule through an ester linkage. The adjacent nucleotides are connected together by phosphodiester bond between phosphate molecule of one and the sugar molecule of other nucleotide forming the sugar-phosphate chain. This is known as polynucleotide chain. The phosphate molecule joins deoxyribose of the next nucleotide. The nitrogenous base is also attached to deoxyribose. These are direced at right angles to the long axis of the polynucleotide chain, and are stacked one above the other.

Procedure

From card board sheet cut the following pieces :

1. (i) Rectangular pieces of 3 cm × 2 cm - 26

(ii) Rectangular pieces of 2 cm × 2 cm - 26

(iii) Circles with a diameter of 1 cm - 25

(iv) Pentagonal pieces with 1 cm length of each side - 25

2. Cut wires of the length of 1.5 cm.

3. Use four different coloured glazed papers for four nitrogenous bases, say -

(i) Red for adenine.

(ii) Blue for thymine.

(iii) Green for cytosine.

(iv) Orange for guanine.

4. Paste these glazed papers on rectangles cut from card board. Thus you have four different types of rectangular pieces (13 each).

5. Write **A** on Red rectangles, **T** on blue rectangles, **C** on green and **G** on orange rectangles.

6. Make holes in them as shown in Fig. 2.2.

7. Paste yellow colour on the circles. Write **P** and make two holes in it as shown in Fig. 2.2.

8. Paste brown colour on pentagonal pieces. Write **S** on each and make holes as shown in Fig. 2.2.

9. With the help of cut pieces of wire join the various cardboard pieces of phosphate, sugar and nitrogenous bases as shown in Fig. 2.2. One phosphate, one sugar and one nitrogenous base when joined together form a nucleotide.

10. Join 25 such units together as shown in Fig. 2.2. This forms a *polynucleotide chain.*

11. Prepare another polynucleotide chain. Care is to be taken that the number of purines in a polynucleotide chain is equal to the number of pyrimidine chain and where there is adenine (A) in one polynucleotide chain there is thymine (T) in the antiparallel polynucelotide chain, or vice versa and similarly for C and G.

12. Now join A of one polynucleotide chain with T of the antiparallel polynucleotide chain with two strings and G with C by three strings as shown in Fig. 2.2.

13. Thus a ladder like structure is prepared. Put this ladder around the vertical rod of the stand that acts as an axis of DNA.

14. Coil it in a right handed helix. It appears like a spiral stair-case around the central axis. Fix the upper and lower edges of the stands.

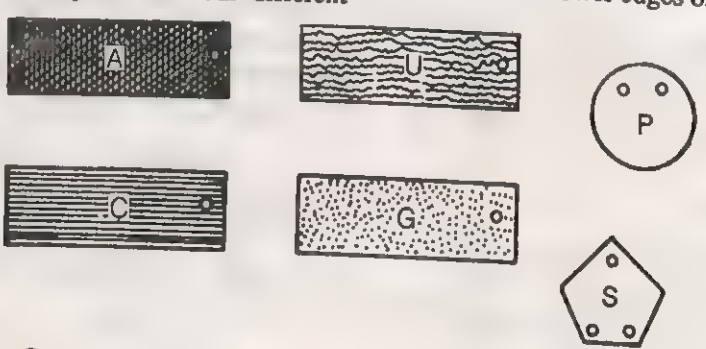


Fig. 2.1 : Cardboard pieces to represent nitrogenous bases, phosphate and deoxyribose.

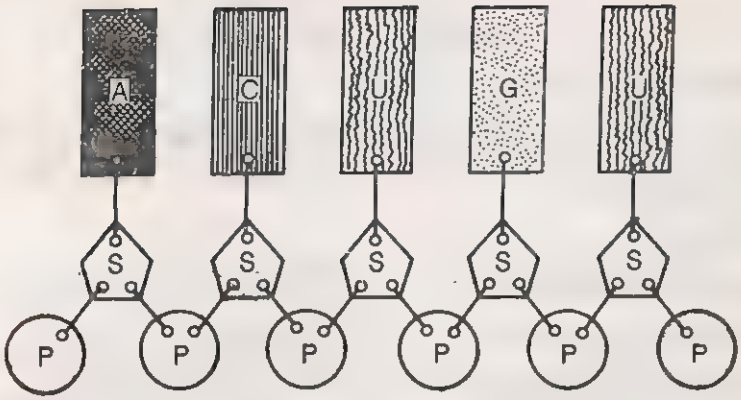


Fig. 2·2 : Preparation of polynucleotide chain.

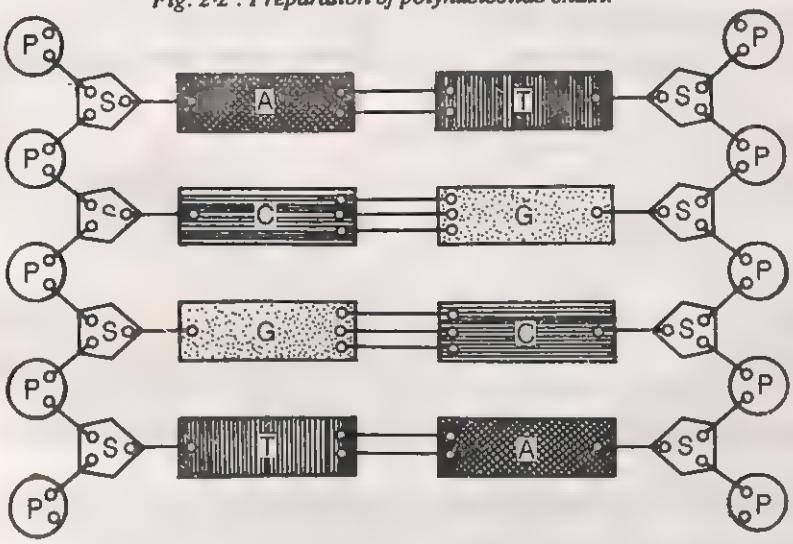


Fig. 2·3 : Arrangement of various components in a molecule of DNA.

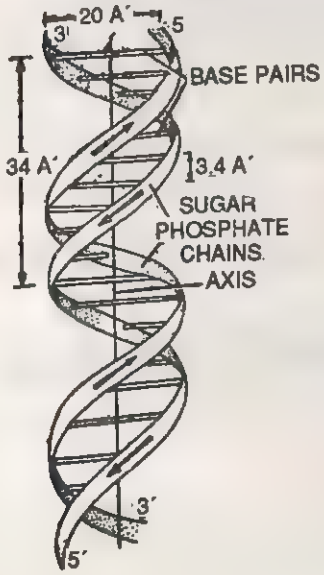


Fig. 2·4 : Double helical structure of DNA.

ORAL QUESTIONS

Q. 1. *What is a nucleoside and nuclotide ?*

Ans . A nucleoside a compound of one of the four nitrogenous bases and a sugar molecule; whereas a nucleotide is formed of one molecule of phosphoric acid combined to a nucleoside (i.e. one base + one sugar molecule + one phosphoric acid).

Q. 2. *Where do you find DNA ?*

Ans . DNA is found in the nucleus.

Q. 3. *Why DNA is called nucleic acid ?*

Ans . Because DNA is found in the nucleus, it is called nucleic acid.

Q. 4. *How many types of nitrogenous bases are found in DNA ?*

Ans . Four types of nitrogenous bases are found in DNA. These are adenine, cytosine, guanine and thymine.

Q. 5. *Name the nucleotides present in DNA molecule.*

Ans . 1. Deoxyadenylic acid, 2. Deoxyguanylic acid, 3. Deoxycytidylic acid, 4.Deoxythymidylic acid.

Q. 6. *Who gave the double helical structure of DNA ?*

Ans . James Datson and F.H.C. Crick.

Q. 7. *Name the type of bond between sugar and phosphate molecules.*

Ans . Phospho-diester bond.

Q. 8. *What type of bonds are present between the nitrogenous bases of two antiparallel chains of a DNA molecule ?*

Ans . Hydrogen bonds. There are two hydorgen bonds between adenine and thynine and three between cytosine and guanine.

Q. 9. *Name of the hereditary material found in eukaryotic cells.*

Ans . Deoxyribonucleic acid (DNA).

Q. 10. *Does RNA acts as hereditary material ?*

Ans . RNA acts as hereditary material in some animal viruses and most plant viruses.

Q. 11. *What is the number of nitrogenous bases in each coil of DNA ?*

Ans . 10 nucleotides are present in each coil of helix. These are separated by specific space.

Q. 12. *What are complementary nucleotides ?*

Ans . These are two nucleotides which pair specifically with each other (i.e. A and T or G and C) are complementary.

□□

INVESTIGATORY PROJECT 3

Preparation of model or chart of mitosis and meiosis

Aim : To prepare model of mitosis and meiosis for the study of various stages of cell division.

Material Required

1. Thermocol sheets or plywood

2. Twisted nylon threads or wool of different colours.

3. Wire or string heads,

4. Coloured pencils or poster colours or oil colours, scale, pencil and rubber.

Theory

Cells arise from the division of pre-existing cells. In fact, the reproduction whether asexual or sexual involves the multiplication of cells. The formation of buds, asexual reproductive bodies or sex cells and the growth and development of every organism involves cell multiplication. The cells multiply by *cell division*. There are two types of cell divisions :

(*i*) *Mitosis* (somatic cell divison) and

(*ii*) *Meiosis* (gametic cell division).

MITOSIS

Occurrence. Mitosis occurs in the somatic cells. It results in the multiplication of cells either for growth or for the replacement of injured or destroyed cells.

Definition : In mitosis the two resulted daughter cells are equal in size and have chromosome number equal to the parent cell. Literally, mitosis (Gk. *mitos*—thread) refers to thread—like chromosomes seen during karyokinesis.

Process of Mitosis : The process of cell division involves two major events :

1. Division of nucleus—**Karyokinesis.**

2. Division of cytoplasm—**Cytokinesis.**

1. Karyokinesis : The process of karyokinesis is a sequence of four stages—**prophase, metaphase, anaphase** and **telophase.**

1. **Prophase :** (i) The chromatin material is condensed into *chromosomes.*

(ii) By the end of prophase each chromosome appears to be double due to lengthwise splitting into two *chromatids.*

(iii) By the end of prophase nucleolus and nuclear membrane disappears.

(iv) In animal cells the two *centrioles* move to the opposite poles and develoop *astral rays* radiating out from each centriole.

(v) *Spindle fibres* appear between the two centrioles.

In plant cells the spindle and spindle fibres are formed but there are no centrioles and no aster and astral rays.

2. **Metaphase** (*meta*—between)—(i) By metaphase chromosomes become more compact and short and the two chromatids in each chromosome become distinctly visible. (ii) The chromosome move towards the equatorial plate of the spindle. (iii) These get so aligned that their centromeres lie on the equator and are attached to the spindle

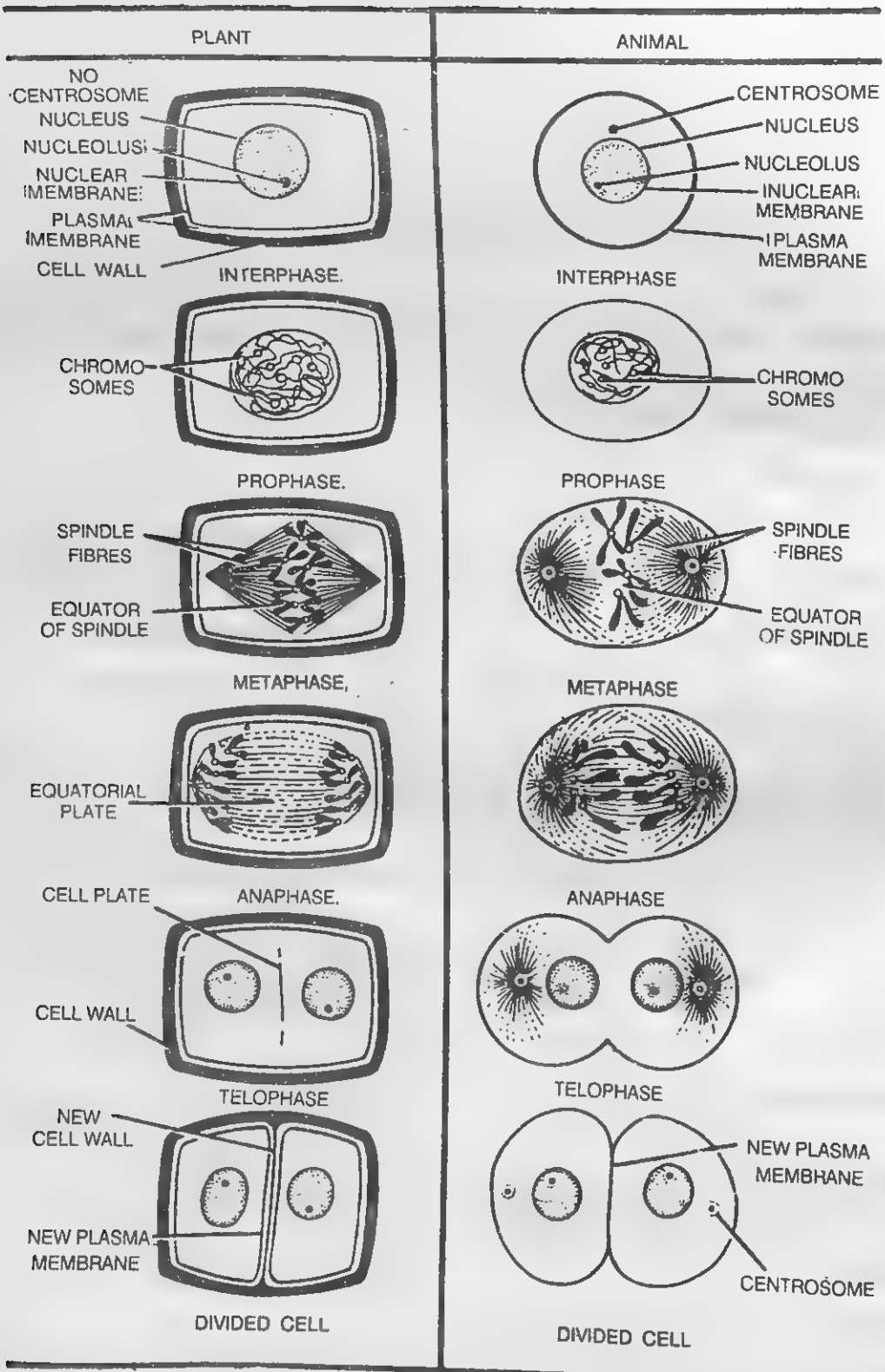


Fig. 3·1 : Diagram to illustrate differences in the process of mitosis in plant and animal cells.

fibres, whereas the **arms are directed towards the poles.**

3. **Anaphase** (*Ana*—back)—(i) The centromere of each chromosome splits lengthwise separating into two sister chromatids. This represents the **daughter chromosomes.** (ii) The daughter chromosomes are pulled apart towards opposite poles of the spindle due to contraction of spindle fibres.

In anaphase, **the arms of daughter chromosomes are directed towards the equator.**

(iii) Chromosomes assume V, U or L shapes. (v) By the end of anaphase the chromosome reach the pole.

4. **Telophase** (Telo—end)—(i) The chromosomes form two groups one on either pole. (ii) The chromosomes uncoil, become thin and long and form the chromatin net (despiralization). (iii) The nuclear membrane and nucleolus are reorganized around each group. (iv) The centriole replicates to form the centrosome.

Thus two daughter nuclei are formed marking the end of karyokinesis.

2. Cytokinesis : Cytokinesis is the division of cytoplasm following the nuclear division, so that the parent cell is divided into two daughter cells. The process of cytokinesis is different in plant and animal cells.

(A) Cytokinesis in animal cells : In animal cell, the cell cytoplasm divides by a furrow or constriction which appears in the cell membrane at the equator. It gradually deepens and splits the parent cell into two daughters cells. The cleavage furrow develops from the periphery towards the centre (**centripetal**).

(B) Cytokinesis in plant cells : In plant cells, a cell plate is formed at the equator of spindle from the vesicles of dictyosome and membranous elements of endoplasmic reticulum. The formation of cell plate progresses from the middle towards periphery (**centrifugal**). The primary walls are deposited on either side of the cell plate dividing the parent cell into two daughter cells.

Significance : 1. Mitosis is a means of reproduction in unicellular organisms.

2. It helps in the growth and development of multicellular organisms from a single-celled zygote.

3. It helps in wound healing, regeneration of damaged parts and replacement of cells lost during wear and tear.

4. Mitosis ensures formation of similarly endowed cells with same number and same kind of chromosomes as in the parent cell.

5. Mitosis maintains the continuity of metabolism by transmitting the same information to its daughter cells as coded in the DNA of parent cell.

6. Unchecked mitosis may lead to cancerous growth.

MEIOSIS

Occurrence : Meiosis occurs only in the germ cells or reproductive cells of gonads resulting in the formation of haploid gametes. In animals it occurs in the cells of testes and ovaries producing sperm and ova (**gametogenesis**) and in plants in the anthers to produce pollen grains (male gametes) or in the ovary producting **ova.**

Process of Meiosis : Meiosis involves two cell divisions followed in close succession.

1. The first meiotic division is the **reduction division** that results in the formation of two **haploid cells.**

2. The second meiotic division is the simple mitotic division dividing each haploid daughter cell into two. Thus four haploid daughter cells are formed from a diploid parent cell.

Germ Cell

First Meiotic division

or

Reduction division

2 Haploid Daughter Cells (n)

Second Meiotic division

or

Equational division

4 Haploid Daughter Cells (n)

Each of the two divisions follow the same sequence as in mitosis. These are as follows—

Meiosis I
or
Reduction Division
(Heterotypic)

- Prophase I
  - Leptotene
  - Zytotene
  - Pachytene
  - Diplotene
  - Diakinesis
- Metaphase I
- Anaphase I
- Telophase I

Meiosis II
or
Equational Division
(Homotypic)

- Prophase II
- Metaphase II
- Anaphase II
- Telophase II

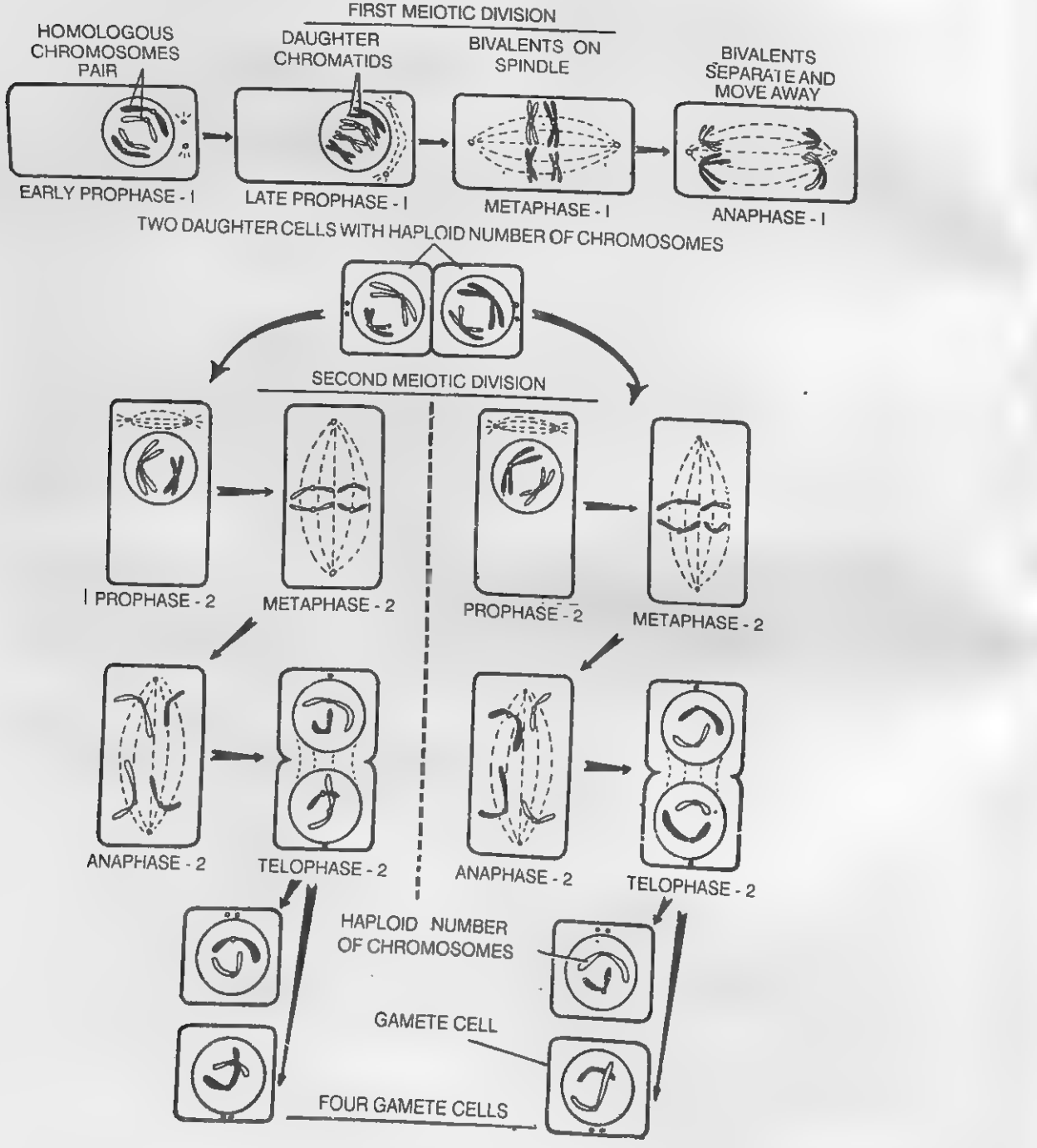


Fig. 3·2 : Different stages of meiosis.

Meiosis I or Reduction Division

1. Prophase I. The prophase stage of first meiotic division is very prolonged and profoundly modified. During this phase following events occur in succession :

(*i*) Chromosomes appear as long fine threads having beaded appearance—**Leptotene** stage.

(*ii*) Homologous chromosome pair and lie close together **forming bivalents-zygotene** stage.

(*iii*) Each chromosome of bivalent appears to be longitudinally splitted into two chromatids. Thus a bivalent changes into a tetrad-**pachytene.**

(*iv*) The homologous chromosomes that had paired during zygotene now start separating, in doing so they exchange segments. The exchange is between adjacent non-sister chromatids of homologous chromosomes. This results in reshuffling of genes. This phenomenon is known as **genetic recombination** (crossing over). The separation is not complete, so that the homologous chromosomes remain joined at one or two points. These are called **chiasmata.** These events occur in **diplotene stage.**

(*v*) The bivalents become very short and thick, the chiasmata move towards the ends of chromosomes **(terminalization).** The nuclear membrane and nucleolus disappear and spindle formation starts—**Diakinesis.**

Metaphase I—The formation of spindle is completed and the bivalents get arranged on the equatorial plate. Their two centromeres remain directed towards the opposite poles and arms towards the equator.

Anaphase I. The individual chromosomes of each homologous pair separate and move towards their respective poles. Thus each pole receives only half the original number of chromosomes.

Telophase I. In telophase, chromosomes at each pole become decondensed and form chromatin net. The nuclear membrane and nucleolus are reformed. By the end of telophase I two daughter cells with haploid nuclei are formed from a diploid parent cell.

Meiosis II

The second meiotic division is essentially a mitotic division. Both the haploid daughter cells divide simultaneously.

Prophase II. Chromosomes reappear by the condensation of chromatin. The nuclear membrane and nucleolus disappear and spindle is formed by the end of prophase.

Metaphase II. Chromosomes get arranged on the equator with their centromeres on the equatorial plate and arms directed towards the poles. Chromosomal fibres of the spindle get attached to the centromere.

Anaphase II. Centromere of each chromosome splits and chromatids separate out as daughter chromosomes. These are dragged towards the poles of the spindle.

Telophase II. The chromosomes despiralize forming the chromatin net. The nuclear membrane and nucleolus are formed in each group. Thus each haploid cell gets divided into two daughter cells.

Significance of Meiosis

1. Meiosis reduces the number of chromosomes to half in the gametes.

2. Meiosis avoids multiplication of chromosome number and helps in maintaining a constant species specfic number, characteristic of the species.

3. During meiosis, crossing over results in exchange of segments between the nonsister chromatids of homologous chromosomes. This produces new combination of genes and introduces variations in the individuals.

EXPERIMENT 1

Preparation of Model of Mitotic Cell Division

Procedure : Take a thermocol sheet. With the help of a pencil mark the outlines of cell and its stages during the mitotic cell division (animal cell) as shown in the figure. Take a kinfe. Keep its blade on the flame of spirit lamp of Bunsen burner to make it hot. Now move the knife on the pencil outlines drawn on the thermocol sheet.

Take another sheet of thermocol. Fix these cut pieces (cells) on this sheet of thermocole in the same design (sequence) as shown in the figure. Fix them with the favicol. (Do not use quick fix as it dissolve thermocole sheet). Now take small bangles to show the region of nucleus in prophase, later prophase, late telophase and interphase stages. With the help of twisted nylon threads of different colours make the chromatin material. Spindle fibres can be shown with the help of ordinary thread of thick dimension. Centromeres can be shown with the help of small coloured granules of equal size (use any material bead etc.) For centrioles you can use small glass balls (marbles).

Colour your model with the help of different colours available to make it attractive. Label the various stages. Model is ready for display.

Note : 1. You can make the model of mitosis in a plant cell in a similar fashion.

2. Try to make another model of this with some other material, say plasticene or clay or plaster of paris.

EXPERIMENT 2

Preparation of Model of Meiotic Cell Division

Follow the same procedure as for mitosis for making meiocytes and various meiotic stages.

ORAL QUESTIONS

Q. 1. *What is mitosis ?*

Ans . Mitosis is the division of a body cell into two daughter cells which have chromosome number of equals to that of parent cell.

Q. 2. *Who coined the term mitosis ?*

Ans . Strassburger.

Q. 3. *During which stage of mitosis chromosomes divide into chromatids ?*

Ans . During late prophase.

Q. 4. *When does chromosomes move towards poles of the spindle ?*

Ans . During Anaphase.

Q. 5. *When does a cell undergoes mitosis ?*

Ans . When nucleocytoplasmic ratio increases.

Q. 6. *Describe significance of mitosis.*

Ans. Mitosis results in the formation of identically endowed cells and helps in the growth and development in multicellular organisms. In unicellular forms mitosis helps in the multiplication of race.

Q. 7. *How spindle febres are formed ?*

Ans . Spindle fibres are formed of protein *tubulin*. The tubulin molecules organize to form spindle fibres.

Q. 8. At what stage of mitosis chromosomes align on the equator of spindle and how ?

Ans. Chromosome align on the equator of spindle during metaphase. The centromere of the chromosomes are aligned on the equator and the arms of chromosomes are directed towards the poles.

Q. 9. *What is synapsis and when does it occur ?*

Ans. Pairing of homologous chromosomes (paternal and material chromosomes) during zygotene (= synaptotene) of prophase - I of meiosis.

Q. 10. *At which stage does crossing over occur during meiosis ?*

Ans. During pachytene stage.

Q. 11. *When does chiasmata are formed ?*

Ans . As a result of crossing over between monoister chromatides of homologous chromosomes, during diplotene stage of meiosis—prophase I.

Q. 12. *Which cells undergo meiosis ?*

Ans . Meiocytes (the germ cells - spermatocyte and oocyte) undergo meiosis to produce gametes.

Q. 13. *What is crossing over ?*

Ans. Exchange of parts between nonsister chromatids of homologous chromosomes is called crossing over.

Q. 14. *What is the term used for pairing of paternal and maternal chromosomes during prophase of meiosis ?*

Ans . Synapsis.

Q. 15. *Point by which a chromosome is attached to the spindle fibre is called—*

Ans. Centromere.

Q. 16. *What structure that initiates spindle formation in animal cells but is absent in plant cells ?*

Ans . Centrioles.

Q. 17. *What is the significance of meiosis ?*

Ans. Meiosis helps in restoring the chromosome number in all sexually reproducing individuls of a species.

Q. 18. *Can a haploid cell divide meiotically ?*

Ans. No, a haploid cell cannot divide meiotically.

Q. 19. *What is the significance of crossing over in meiosis ?*

Ans . During crossing over in meiosis exchange of genetic material between non-sister chromatids occurs, as a result the genotype of the cells is altered. So it results in the genetic recombination and finally helps in the formation of new species.

Q. 20. *What is a meiocyte cell ?*

Ans . A cell that is to divide by meiosis is called a meiocyte.

Q. 21. *From one parent cell how many daughter cells will be produced after meiosis and after mitosis ?*

Ans. From one parent cell two cells will be produced after mitosis and four cells after meiosis.

Q. 22. *What do you mean by the term karyokinesis ?*

Ans . Karyokinesis means the division of the nucleus.

Q. 23. *What do you mean by cytokinesis ?*

Ans . It is the division of the cytoplasm.

Q. 24. *How do you differentiate the chromosomes of mitosis and meiosis ?*

Ans. Meiotic chromosomes are comparatively longer and thinner. They show a characteristic beaded appearance by the presence of chromomeres.

Q. 25. *At what stage of cell division, does nuclear membrane reappear ?*

Ans . Telophase.

Q. 26. *Suppose we take a cell from a leaf instead of root tip, will mitotic events be seen ?*

Ans. No, as the cells of leaf do not divide.

Q. 27. *Why is mitosis termed as equational division and meiosis as reduction division ?*

Ans. Mitosis is equational division because the daughter cells formed are identical to the

Q. 28. *Suppose a cell has 44 chromosomes. How many chromosomes will it have after mitosis ?*

Ans. 44. In mitosis the daughter cells produced have the same number of chromosomes as the parent cell.

Q. 29. *Who described the process of mitosis and meiosis for the first time and in which year ?*

Ans . Mitosis was first described by W. Flemming in 1882; while meiosis was first described by Winiwarter (1900), and Farmer and Moore in 1905 coined the term meiosis.

Q. 30. *In which stage of cell division chromosomes are seen best ?*

Ans . At metaphase stage.

Q.31. *Name the chemical that can arrest the process of cell division at metaphase stage ?*

Ans . Colchicine.

□□

INVESTIGATORY PROJECT 4

MINERALS AND THEIR ROLE IN PLANT GROWTH

DETERMINATION OF ESSENTIALITY OF MINERALS FOR PLANTS GROWTH RECORDING OF DEFICIENCY SYMPTOMS

Aim : To determine essentiality of minerals for plant growth. Record deficiency symptoms.

MINERAL REQUIREMENTS OF PLANTS

Minerals are inorganic component of food. These are chlorides, sulphates, carbonates, phosphates and iodides of sodium, potassium, calcium, magnesium, and iron. These are essential in the life of a plant. With the exception of carbon and oxygen, are obtained from the soil. Carbon and oxygen are obtained from the air. The utilisation of absorbed minerals by a plant for growth is known as mineral nutrition. On the basis of their requirement, the mineral nutrients are of two types—macronutrients and micronutrients.

Macronutrients are essential elements. These are meant for normal and healthy growth of the plant. They are required in large quantities. Micronutrients or nonessential elements give some special benefit to the plant and are required in minute quantities only. Boron, manganese, copper, zinc and molybdenum are the micronutrients or trace elements.

Fig. 4·1 : (A) Tomato leaf showing patassium deficiency. (B) Sugar beet plant showing calcium deficiency. (C) Radish plant showing magnesium deficiency.

(A) Macronutrients

Carbon, hydrogen, oxygen, phosphorus, sulphur, nitrogen, potassium, calcium, magnesium and iron are the macronutrients.

Material Required

Normal culture or nutrient solutions - (Knop's solution, Sach's solution, Hoagland solution etc.) Different culture media each with a deficiency for one mineral nutrient.

Maize seeds, Balance Bottles/Jars, Sand, Earthen pots.

Procedure

1. Prepare a normal standard culture solution (water culture solution) in a beaker or a bottle as given below (Sach's solution).

This was worked out by Knop and is called 'Knop's' normal culture medium.

2. Prepare various other solutions also showing the deficiency of different minerals. For iron definiency—use calcium phosphate instead of ferrous sulphate; for potassium deficiency—use calcium sulphate instead of potassium nitrate; for magnesium deficiency—use calcium sulphate instead of magnesium sulphate; for phosphorus deficiency—use calcium sulphate instead of calcium phosphate etc. Thus prepare various solutions deficient in iron, nitrogen, magnesium, phosphorus etc. and keep them in separate bottles. Cork these bottles.

3. Grow some seeds of gram (or maize or bean) and develop the seedlings. Now fix the seedlings to these bottles carefullly. *It is important to note that all the seedlings fixed must be of same size and having equal development.*

4. Observe the growth of these plants daily for about 15 days or so in various bottles and record them. Make notes and draw diagrams. If possible, take their photographs also.

A. SACH'S SOLUTION		B. KNOP'S SOLUTION	
Potassium nitrate KNO_3	—1.00 g	Calcium nitrate $Ca(NO_3)_2$	0.8 g
Calcium phosphate $Ca_3(PO_4)_2$	—0.50 g	Potassium nitrate KNO_3	0.2 g
Magnesium sulphate $MgSO_4$	—0.50 g	KH_2PO_4	0.2 g
Calcium sulphate $CaSO_4$	—0.50 g	Magnesium sulphate $MgSO_4$	0.2 g
Sodium chloride NaCl	—0.25 g	Ferrous sulphate $FeSO_4$	Traces
Ferrous sulphate $FeSO_4$	—0.10 g		
Distilled water	—1000 ml		

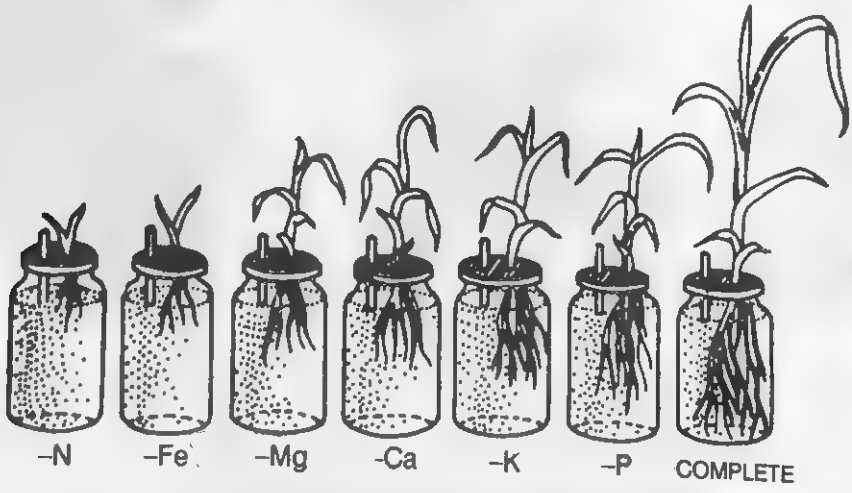


Fig. 4·2 : Experiment to demonstrate the effect of the deficiency of macronutrients.

Observations :

No. of days	*Comments on the growth of*		
	Gram plants	*Maize plants*	*Bean plants*
After 2 days			
5 days			
10 days			
12 days			
15 days			
20 days			
and so on			

Deficiency	*Chracteristics*
Nitrogen	Pale grene; older leaves become yellow and dry; stems short and dry, excessive deficiency reduces root system and delays flowering and seed formation.
Sulphur	Light green young leaves.
Phosphorus	Retarded root growth; Dark green; development of purple anthocyanin pigments, older leaves become yellow and dry; stems short and slender.
Calcium	Terminal buds die, chlorosis and necrosis of leaf margins, stunted growth of root.
Potassium	Chlorotic leaves; tip of leaf dies; dead dry spots in leaf between vein and on edges.
Magnesium	Chlorotic leaves (interveinal chlorosis and necrosis); edges of leaves curled.
Iron	Chlorosis of young leaves (interveinal chlorosis); stems short and slender.
Boron	Terminal bud light green; stalk withered near apex (Heart rot of beets, drought rot of apples, stem crack of cellery and water core of turnip).
Manganese	Leaf spotted by dead, dry areas (chlorotic and necrotic spots in the interveinal regions of the leaves).
Copper	Wilting of young leaves; tip of stem drops.
Zinc	Large, dead dry spots over entire leaf; leaves become thick due to reduction in the length of internodes; leaves present rosette type of growth.
Molybdenum	Mottling and necrosis; premature falling of flowers.

ORAL QUESTIONS

Q. 1. *What is mineral nutrition ?*

Ans . The utilization of various element ions absorbed by plant for its growth and development is called *mineral nutrition.*

Q. 2. *What do you mean by macronutrients ?*

Ans . *Macronutrients* are those element ions which are required by plants in large amounts for proper growth and development, e.g. carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, calcium, iron etc.

Q. 3. ***What are micronutrients ?***

Ans . ***Micronutrients*** are required by plants in very small quantities.

Q. 4. ***Which elements are called essential elements ?***

Ans . The mineral elements which are absolutely essential for plant growth and development are called ***essential elements.*** 17 elements are described as essential elements.

Q. 5. ***What are hunger signs ?***

Ans . ***Hunger signs*** are symptoms shown by plants due to deficiency of a particular mineral element.

Q. 6. ***What is chlorosis ?***

Ans . ***Chlorosis*** is yellowing of leaves at the tips and margins caused due to deficiency of potassium and magnesium.

Q. 7. ***What are hydroponics ?***

Ans . ***Hydroponics*** is the science of culturing plants in water or without soil.

□□

INVESTIGATORY PROJECT 5

SEED DORMANCY

STUDY OF BREAKING OF DORMANCY OF SEEDS BY CHEMICAL AND MECHANICAL TREATMENTS

Aim : To study the effect of mechanical, chemical or hormonal treatment on the germination of seeds.

DORMANCY

Freshly harvested seeds are incapable of germination even under favourable conditions. This natural barrier of development which is gradually overcome with time is called *dormancy*. One can break dormancy by following methods.

1. *By mechanical scarification*. Seeds having very hard coat when scratched with some abrasive material, softens the seed coat and makes it pervious to water.

2. *By chemical sacrification*. Seeds when dipped in strong acids (H_2SO_4) or organic solvents e.g., acetone, alcohol or even boiling water, breaks dormancy by weakening the seed coat.

3. *By treating with hormone*- gibberellic acid to break dormancy.

EXPERIMENT 1

Aim : To study the effect of chemicals on *Xanthium* seeds to break seed dormancy.

Material Required

Laboratory's Requirements : KNO_3, conc. HNO_3, conc. H_2SO_4, *Xanthium* seeds, Petridishes, forceps, scissors, filter paper, beaker, distilled water, etc.

Method : Line four Petridishes (label them as A, B, C, D) with doubled filter paper, moisten well with distilled water. Take four beakers filled with distilled water, KNO_3, conc. HNO_3 acid, conc. H_2SO_4 and label them as *a, b, c, d respectively.*

(i) Take four batches of xanthium seeds of five seeds each.

Table 5·1 : Effect of chemicals to break seed dormancy

Kind of Treatment	*No. of seeds sown*	*No. of seeds germinated*	*Per cent germination*	*Per cent inhibition*
1. Distilled water				
2. KNO_3				
3. HNO_3				
4. H_2SO_4				

(ii) The *Xanthium* seeds of first batch and were in petridish A containing pad of cotton made wet with distilled water.

(iii) Put seeds of second batch in beaker containing KNO_3 solution; of third batch in beaker containing HNO_3 and of fourth batch in beaker containing H_2SO_4.

(iv) After about 3-4 hours wash seeds of each batch separating and put them in petridishes B, C and D respectively.

(v) Put all the four petridishes under same conditions of temperature, moisture, air and light.

(vi) Keep the seeds and underlying cotton pad moist all the time.

(vii) Note the time taken for germination by seeds in each of the four petri dishes.

Observations

Record your observations in the table given below :

You will find that after a few days seeds of petri -dish B (KNO_3 treated), C (HNO_3 treated) and D (H_2SO_4 treated) start germination but seeds of petri -dish A (given only distilled water) do not germinate. This is because seed coat of *Xanthium* seeds is not permeable to water but when they are treated with chemicals, seed coats become permeable to water. Find out maximum and minimum germination percentage. Illustrate your results with a suitable table and give your interpretation.

Conclusion : Maximum seed dormancy is broken in sulphurric acid treatment.

EXPERIMENT 2

Aim : To study the effect of mechanical treatment to break seed dormancy.

Material Required

Student's Requirements : Same as required for Experiment 1.

Laboratory's Requirements : 20 seeds of family *Leguminosae* (bean) and 20 seeds of tomatoes, distilled water, sand paper, needles, bottle, Petri dishes, filter paper, etc.

Method

Line four Petri dishes with doubled filter paper, moisten well with distilled water. Abrade 5 seeds of bean and 5 seeds of tomatoes with sand paper. Similarly seed coats of 5 seeds of bean and of 5 seeds of tomatoes are pored with ordinary needle. Likewise other set of seeds is shaked in a bottle vigourously. Another set of seeds (5 those of bean and 5 of tomato) is not given any mechanical treatment. Sow these seeds in 4 separate Petri dishes (Each Petri dish having 10 seeds : 5 of bean and 5 of tomato but of one treatment). Allow the seeds to germinate in a suitable place and conditions.

Observations

After a few days seeds start germination. Seeds without any mechanical treatment either will not germinate or will show poor germination due to mechanical resistance (hard seed coats). Abrasion, blowing against needle points and impaction by shaking in a bottle, etc. are common and cheapest methods which are generally employed to overcome hard seed coatedness. In all sets illustrate your results with a table.

Table 5.2 : Effect of mechanical treatment to break seed dormancy

Kind of Treatment	*No. of seeds sown*	*No. of seeds germinated*	*Per cent germination*	*Per cent inhibition*
1. Without mechanical injury				
2. Sand paper abrasion				
3. Needle pricking				
4. Bottle shaking				

Conclusion : Mechanical treatments are also successful to some extent in breaking the seed dormancy.

EXPERIMENT 3

Aim : Effect of Hormone on seeds (wheat grains) germination.

Procedure

Take 2 sets of 10 seeds of wheat. Put first set of 10 wheat seeds for germination in a petridish with a wet cotton pad.

Place the second set of seeds in a petridish as above. Put this petridish on a glass and cover it with a belljar. Seal the joining surface of belljar and glass sheet with grease or petroleum jelly. Now, pass cooking gas in the belljar with the help of a rubber tubing through the opening at the top of the belljar for 1 minute. The rubber tube should reach just above the bottom of the belljar. Quickly, replace the stopper on the mouth of the belljar and seal it with the petroleum jelly.

Pass cooking gas after every 12 hours inside the belljar to compensate the gas lost due to diffusion.

Note the time of germination in both the petridishes. Also, measure the length of radicle and plumule.

Effect of Gibberellic acid on Wheat Seed Germination

Procedure

Soak 10 seeds of wheat in 10–4 M solution of gibberellic acid for few hours. Place these seeds for germination in a petridish. In the second petridish put another set of 10 seeds of wheat for germination.

Compare the time taken for germination in both the cases.

Note. You may also select pea seeds for this experiment.

ORAL QUESTIONS

Q. 1. *List the various plant hormones.*

Ans . These are (a) Auxins, (b) Gibberellins, (c) Cytokininis and (d) Abscisic acid.

Q. 2. *Name the growth regulators which promote seed germination.*

Ans . Gibberellins.

Q. 3. *Which of the growth regulators play an impotant role in the development of seeds from ovule ?*

Ans . Auxins.

Q. 4. *Name one plant growth substance which regulates cell elongation.*

Ans. Gibberellins.

Q. 5. *Describe the functions of gibberellins.*

Ans. Funtctions of Gibberellins.

(i) Effect on stem elongation. Gibberellins are found to cause stem elongation in genetically dwarf variety. It has no effect on tall varieties.

(ii) Germination of seeds. It is now known to control the germination of seeds of some higher plants such a lettuce, cereals etc.

(iii) Flowering. Gibberellins induce flowering in the long day plants in short day conditions.

(iv) Parthenocarpy. Gibberellins are found to induce parthenocarpy (seedless furits).

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INVESTIGATORY PROJECT 6

PLANT MOVEMENTS

STUDY OF THE EFFECT OF LIGHT AND GRAVITY ON PLANT MOVEMENT AND ROLE PLAYED BY THEM

Aim : To study the effect of light and gravity on the plant movement and the role played by them.

Introduction : In plants, the movements are in response to certain stimuli. These movements are caused by differential growth producing curvature bending in growing regions. Such movements are called *tropic movements.* Depending upon the nature of stimulus, the important tropic movments are—

1. *Phototropism*—It is the differential growth response of the plant to light. This causes bending of plant towards source of light.

2. *Geotropism*—It is the differential growth response in the root and shoot of plants in relation to gravity.

3. *Hydrotropism*—It is movement in response to water.

4. *Chemotropism*—It is the movement in response to chemicals.

EXPERIMENT 1

Aim : To study the effect of light on the plant movement and the role played (Phototropism).

Material Required

A wooden box about 2′ × 1′ × 1′(*Phototropic chamber*) painted black inside and having a light screen or a small hole on one side (a window), potted plants, flower pots, seeds, heliotropic chamber.

Procedure

1. Put a potted plant in a wooden box which acts as a dark chamber for the plant and allows the light to pass in the wooden box through a window on one side.

Observation

After few days you will observe that the stem tip bends towards the source of light *i.e.*, towards the window.

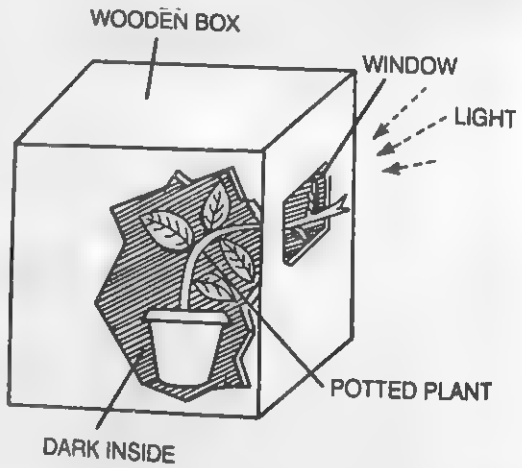

Fig. 6-1 : A potted plant placed inside dark box. Note it bends toward window or source of light.

2. Take a potted plant and keep it in a dark room near an open window. Observe the plant for a week. Do you find any change in the plant ? In which direction the stem of the plant has moved (see Fig. 6.2).

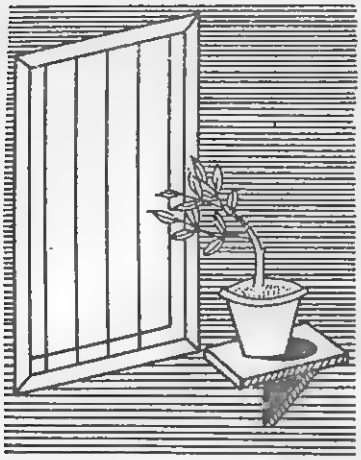

Fig. 6·2 : A potted plant placed inside dark box. Note it bends towards window or source of light.

3. Take four flower pots, grow some fast growing seeds in them. Keep the pots in a darkened room until the seedlings are about 2.5 cm high. Place one pot in a sunny window. What do you observe ?

Turn the plants away from the light.

What do you observe ?

Leave the pot in a place away from direct light for a few days.

What do you observe ?

EXPERIMENT 2

Experiment to show that shoots are positively phototropic and roots negatively phototropic.

Place the wheat seeds in three petridishes containing wet cotton wool. Keep these three petridishes in dark for germination till the coleoptile of the seedling becomes about 1.5 cm. long.

Remove 2 mm. of the tips from all the coleoptile of the first petridish. Cover the tips of all the coleoptile of the seedling in the second petridish with the help of the aluminium foil. Leave the coleoptile tips intact in the seedling of the third petridish. Now, place the three petridishes in the

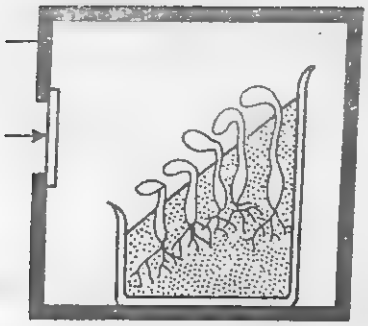

Fig. 7·3 : Heliotropic chamber.

black box and place a source of light near the slit of the box. Leave the seedlings in the box in the same situation for 24-28 hours.

Observation

Observe the curvature in the seedlings. The coleoptiles of seedlings bend towards source of light. You will observe the effect of light, causing bending of the shoot towards light in the seedlings with coleoptile tips intact.

Explanation

The positive response is given by the stem apex or the stem tip bends towards the source of light is due to more growth rate on the shade side than the exposed side of the stem apex. This is due to accumulation of more auxin on the shade side than of the exposed side which stimulates more growth on the shade side than the exposed side as a result of which the tip portion shows curvature towards the source of light.

Result

The stem tip shows a positive phototropism and roots show negatively phototropism and move away from source of light.

EXPERIMENT 3

Effect of gravity on plant movements—Geotropism

The movement of plant organs in response to the force of gravity is termed as geotropism.

Material Required

Clinostat, potted plant, pot, bean seeds.

Procedure :

Attach a potted plant to disc of clinostat. Its disc rotates on the rod with the help of a clock work mechanism. Keep the apparatus in horizontal position and set the clock work. Due to this, the disc as well as the potted plant gets rotated so that all sides of the plant receive geotropic stimulus equally.

Now observe the following :

Do you observe any curvature in the stem in the moving or rotating plant ?

Do you observe any curvature in the root in the rotating plant ?

No curvature in root or shoot is seen when the clock work mechanism was in progress. However when the rotation of clinostat was stopped, for a few days, the stem began to move upwards (Negatively geotropic).

Observation

It is observed that the plant remains as such i.e. root and stem remain in the horizontal plan and no curvature in the root and stem is produced.

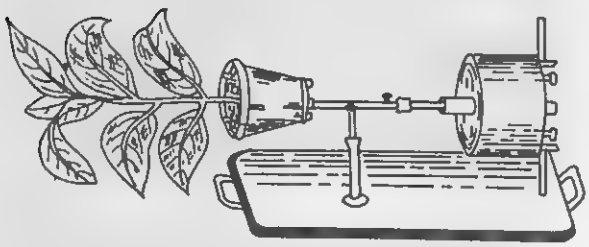

Fig. 6·4 : Clinostat.

Explanation

This is due to the fact that during rotation of pot all the sides of the plant equally lie in the horizontal plane thus the auxin is equally distributed on all sides of the stem and root apex, thus equal growth takes place on all sides and hence no curvature is produced in root as well as stem.

Result

Potted plant placed horizontally and rotated on the disc of clinostat fail to show geotropism.

Note : If you keep a potted plant on the table in a horizontal plane, next day you will observe that its stem apex bends upwardly due to the unidirectional distribution of auxin as already discussed in the previous experiment.

2. Fix a blotting paper on the side and attach a seedling (germinating maize or gram seeds). Prepare two sets A and B. Now insert a slide in such a way that the root is placed in downward direction and stem in upward direction and B slide is placed in such a way that the root and shoot both are placed in a horizontal direction. Moist the blotting paper regularly to provide moisture to the germinating seedlings. Observe the set A and B after few days.

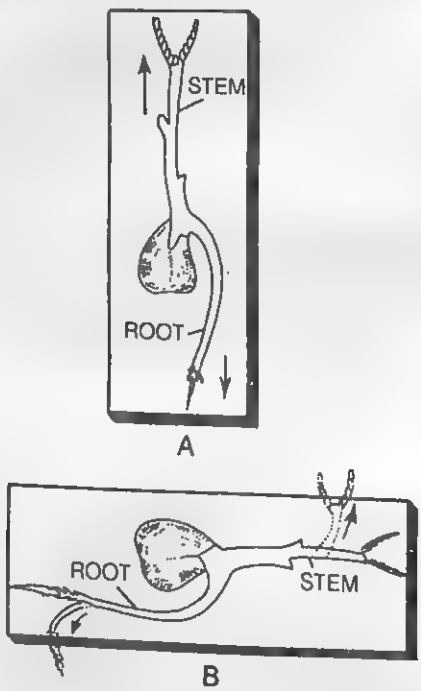

Fig. 6·5 : Experiment to show that roots are positively geotropic.

Observation

In A set it is observed that the root is growing in the downward direction and shoot in the upward direction. In B set it is observed that the shoot tip bends upwardly (Away from gravity (and root tip) downwardly (towards the gravity)).

Conclusion

The curvature depends upon the concentration of auxins on the lower side of root and shoot apex. A higher conc. of auxins on the lower side of the stem tip stimulates its growth on this side only and, therefore, a negative geotropic curvature takes place. In case of root tip, the high concentration of auxins on the lower side inhibits the growth on this side and therefore a positive geotropic curvature takes place.

Result : Stem tip shows a *negative geotropism.*

ORAL QUESTIONS

Q. 1. *What is phototropism ?*

Ans . Phototropism is the response of a plant or plant part towards sunlight. It may be positive phototropism or negative phototropism.

Q. 2. *Which part of the plant is negatively phototropic ?*

Ans . Root is negatively phototropic.

Q. 3. *Which part of the plant body react to stimuli from light or gravity ?*

Ans . Root tip and shoct tip.

Q. 4. *Name the root which is negatively geotropic.*

Ans. Pneumatophores found in mangrove plants are negatively geotropic.

Q. 5. *Which apparatus is used to demonstrate effect of geostropism ?*

Ans . Clinostat.

Q. 6. *How does a plant bend towards source of light ?*

Ans . Plant bends towards source of light because of differential production of growth hormones (auxins).

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INVESTIGATORY PROJECT 7

POLLEN STRUCTURE

STUDY OF STRUCTURE OF POLLEN AND CALCULATION OF POLLEN VIABILITY

Aim : To study pollen structure and calculation of pollen viability.

Introduction : Pollen grains are the *haploid male gametophytes*. These are formed inside the pollen sacs of anthers of a flower as a result of meiotic division. The pollen grains are initially grouped in tetrads.

Pollen grains appear as dust particles. Each is a minute structure varying from 10 to 200 microns. Their shape varies and may be spherical, subprolate, prolate or perprolate. Each pollen grain consists of centrally placed two *nuclei*, dense *cytoplasm* enclosed in two coats. The outer coat or *exine* is tough, cutinized and protective. The inner coat or *intine* is thin and delicate. The bigger nucleus is called *tube nucleus* and smaller one *generative* nucleus.

Material Required

Petridishes,	Acetocarmine stain
Slides,	Distilled water
Coverslips,	Glycerine
Microscope,	Magnesium sulphate
Beakers,	Boric Acid.

Flowers : China shoe flower, *Petunia*, Candituft, Goldmohar, Sunflower, Larkspur, Sweet Pea or any other flower.

STUDY OF STRUCTURE OF POLLEN

Procedure

1. To observe the structure of pollen grains, take a drop of glycerine on a clean glass slide. Dust pollen grains of a mature androecium on it. Now, put a converslip and observe under a compound microscope. Repeat the experiment to observe the pollen grains of different flowers.

2. Dust pollen grains from a mature anther on a clean slide or tease a few anthers in a drop of distilled water on a clean slide. Put a drop of acetocarmine. Put a coverslip and after about 5 minutes study under the low and then high magnification of microscope.

Observation table : Note on the shape of pollen grains of different flowers

S. No.	*Name of the flower*	*Shape of the pollen grain*
1		
2		
3		
4		
5		

Observation

Draw diagrams of the observed pollen grains and find out the different patterns of the pollen grain wall of the different flowers.

Results

A pollen grain is a mature microspore. It has a highly specialised cell wall that consists of two main layers viz., an outer exine and an inner intine. Chemically exine is made up of sporo-pollenin which is resistant to chemicals and biological degradation. In insect pollinated flowers, it is covered by a yellowish viscous and sticky substance called pollenkitt. The outer surface of exine has various ornamental shapes characteristic to a spacies. The intine is made up of cellulose and pectin.

During germination of pollen grain exine becomes thin at one or more points and intine comes out of it as a pollen tube. These points are called *germ pores*.

Counting of Infertile Pollen Grains

Dissolve sucrose, boric aicd, magnesium sulphate and potassium nitrate (the quantity should be as indicated above) in 100 ml of water. Stock this solution in a reagent bottle. This solution acts as a nutrient for the developing pollen grains.

Take a few drops of this solution on a clean plain slide side (for activity slide). Now, dust the anthers of the flowers over this solution on the slide.

Observe the slide under dessecting or compound microscope after 5 minutes and then regularly after every minute.

Repeat your experiments with differnt types of flowers (Petunia, Gold mohar etc.).

Observations

Count the number of pollen grains which have not germinated at all. These are actually infertile pollen grains.

Record your observation in the following table.

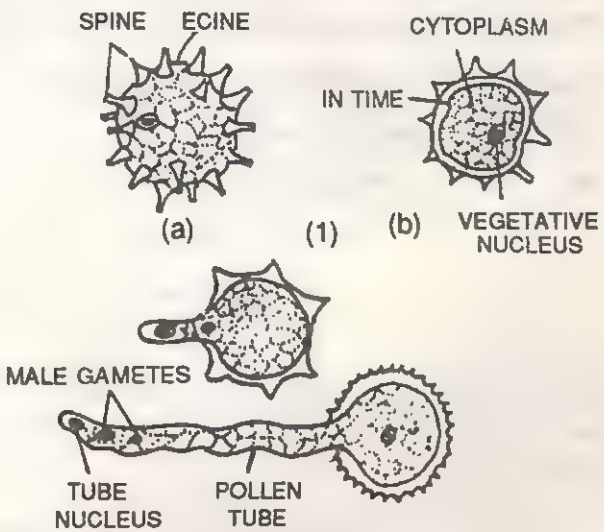

Fig. 7-1 : Structure and germination of pollen grains.

Observation Table :

S. No.	*Name of the flower*	*Time taken in germination of pollen grains*	*Number of infertile pollen grains*	*Which flower shows more number of infertile pollen*
1.				
2.				
3.				
4.				
5.				

Conclusion

(i) Mature pollen grains germinate in a suitable media but infertile pollen grains do not germinate.

(ii) Pollen grains which do not gain stain are sterile or infertile.

(iii) Percentage of infertile pollen grains is different in different flowers.

ORAL QUESTIONS

Q. 1. *What are pollens ?*

Ans. Pollens are male gametophytes.

Q. 2. *What is the role of exine ?*

Ans . (1) It forms a protective covering.

(2) It helps in dispersal of pollen grains and their transference to the stigma either by being blow or by air or by getting stocking to the body of some animal.

Q. 3. *What does the study of pollen grains known as ?*

Ans. Palenology.

Q. 4. *What is the tissue from which pollen grains arise ?*

Ans. From microscope mother cells or sporogenous cells of microsporophyll (anther).

Q. 5. *Give an example each, where pollen grains are (i) winged, (ii) form pollinium.*

Ans. (i) Winged pollen grains e.g. *Pinus*

(ii) Pollinium e.g. Orchids.

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INVESTIGATORY PROJECT 8

POLLEN GERMINATION

COMPARATIVE RATES OF POLLEN GERMINATION OF VARIOUS SPECIES

Aim : To make a comparative study of rate of germination of pollen grains of different species.

Material Required

10g. sugar, 10 gm. boric acid, 30 mg. Magnesium, cavity slide, coverslip, Microscope, 20 mg KNO_3.

Introduction

Pollen grains are produced in the anthers by meiosis. Therefore, these are haploid. These ensure fertilization of ovule.

Pollen grains germinate on reaching the stigma of flowers of same species. During pollen germination, a pollen tube grows out of pollen grain through germ pore by breaking through exine of pollen in this region. The nucleus of pollen divides into two by mitosis.

(i) Generative nucleus

(ii) Tube nucleus

The pollen tube grows down through the style and carries the tube nucleus followed by generative nucleus. The generative nucleus later on divides

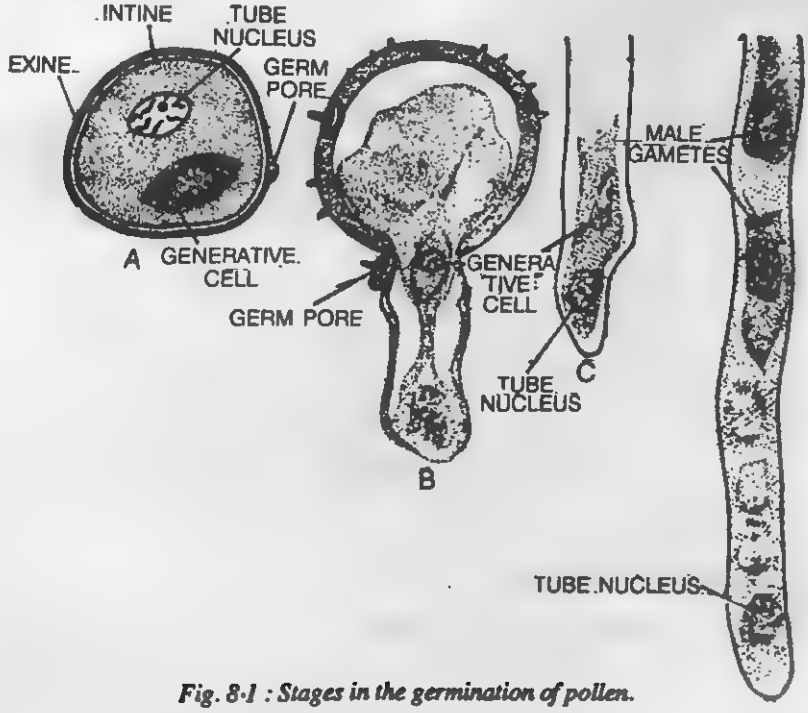

Fig. 8·1 : Stages in the germination of pollen.

into two male nuclei or the male gemetes. The pollen tube enters the micropyle of ovule and releases two male nuclei in the ovule to ensure double fertilization.

Procedure

1. *Preparation of culture medium.* Prepare 10% sugar solution (i.e. 10 gm sugar in 100 cc water). Dissolve other ingredients i.e. boric acid, magnesium sulphate and potassium nitrate in sugar solution. This is the nutrient solution.

2. Take 5-10 clean cavity slides. Put 2-3 drops of nutrient solution in each cavity slide. Number the slides as 1, 2, 3, - - - - -.

3. Take flowers of 5-10 different species or groups. Note down the name of each flower and number them.

4. Dust a few pollen grains from flower 1 in the nutrient drops on slide no.1 and similarly pollen from other flower is dusted on the slides with respective numbers.

5. Cover it with coverslip.

6. Observe each slide under dissecting microscope and note the time of appearance of pollen tube.

7. After 5 minutes observe each slide one by one under low magnification of microscope and note down the size of pollen tube in each case.

8. Repeat your observations after 10 minutes.

Observation

Record your observation in the table given below.

Conclusion

Pollen grains germinate in sugar solution, which acts as a nutrient. Water absorbed by pollen grains causes the rupture of exine and nutrients induce growth of pollen. In some species, the percentage of sterile pollen is more and in others less. In some cases the pollen do not germinate at all. Such plants are called male sterile plants. If percentage of nongerminating pollens is more than the germinating pollen, these are called semisterile. In case the number of nongerminating pollen grains is far less than the number of germinating seeds, the plants are called fertile.

Precautions

1. The pollen from one species shall not mix with other pollens.

2. Only a few pollen shall be dusted in each slide.

3. Ensure that pollen dusted by you are placed on the nutrient drop on the cavity slide.

Observation Table

S. No	*Name of the flower species*	*Time taken for the appearance of pollen tube*	*Appearance of pollen tube after 5 minutes*	*Appearance and length of pollen tube after one minute*
1				
2				
3				
4				
5				

ORAL QUESTIONS

Q. 1. *What are pollen grains ?*

Ans . Pollen grains represent male gametophyte.

Q. 2. *What is the number of chromosomes in pollen grain ?*

Ans. Pollen grains contain haploid number (= n) number of chromosomes.

Q. 3. *Name the tissue from which pollen grains are formed ?*

Ans. In Microsporangial tissue (from microspore mother cells or sporogenous cells).

Q. 4. *What will happen if pollen grains are grown in water ?*

Ans . (1) Because of lack of nutrients pollen grains will not grow.

(2) Due to excess of water being absorbed in pollen grains (due to endosmosis) the pollen grains will rupture.

Q. 5. *What are pollinia ? Where are these found ?*

Ans. Pollinia are pollen grains agglutinated into a sac-like body. These are found in *Calotropis* and orchids.

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INVESTIGATORY PROJECT 9

APICAL DOMINANCE

STUDY OF APICAL DOMINANCE IN POTATO AND COLEUS PLANTS

Aim : To study Apical Dominance in potato and coleus

Material Required

Earthen ware pots or trays or seed boxes, soil, lanolium paste, indolacetic acid (IAA), hand lens, potted coleus plant without branches, potato tuber with eyes, measuring tape, blade, match sticks.

APICAL DOMINANCE

Growth in flowering plants is restricted to definite regions. These regions are called *meristems*. Since the growth takes place mainly in the apical regions (shoot and root tips), the meristems are termed as *apical meristems*. The cells of meristematic tissue are capable of undergoing continuous division. These cells then get differentiated into various other kinds of tissues or cells for the working of the plant.

Growth is also under the influence of chemical substances called auxins produced at the root and shoot tip. The auxins secreted by apical meristem suppress the growth in the lateral buds, i.e., while the main *apical meristem is active it retards the activity of the more recently created lateral meristem.* This correlative inhibition of lateral buds by auxin form apical bud is known as *apical dominance*. If the tips of the shoot are removed, the lateral buds, begin active growth. This is most commonly seen in trees that have been chopped and it is the reason why it is possible to grow dense hedges with many lateral branches by removing the terminal buds at regular intervals.

The degree of apical dominance in stems varies from species to species. Three different factors namely - growth hormones (auxins, gibberellins and cytokinins), mineral nutrients and carbohydrate level are responsible in controlling phenomenon of apical dominance.

Procedure

1. Take three earthenware pots having moist soil in each. Label them as A, B and C. Put whole potato tuber for growth in pot A; in pot B put the potato tuber from where eyes or buds are removed; and in pot C put only the eyes or buds with little potato tuber portion attached to it. Keep these pots separately and in identical conditions and allow the potatoes to grow for about 30 days. Water all the three pots at regular intervals so that they do not get dried. Observe and record the growth of potatoes in each. Note your observations in the following manner :

1. Measure the height regularly on alternate days.

2. Count the number of full sized leaves at regular intervals.

3. Count the number of nodes at regular intefvals.

4. Note the time of appearance of lateral buds, the primary auxillary branches and secondary branches.

5. Note the time of appearance of lateral buds and branches.

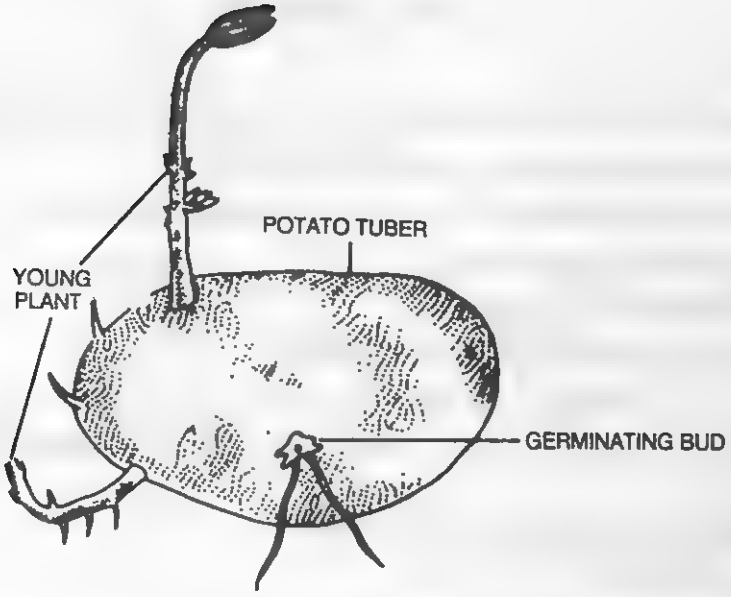

Fig. 9·1 : Growth in a potato.

2. Take two potted plants of *Coleus* (A and B) that are growing well and almost of the same size, and also not showing side branching. Count the number of leaves and nodes. In pot A—decapitate or cut the shoot apex (**prunning**) from the plant; and in pot B let the shoot apex remains intact (control experiment). Now keep these two potted plants separately for their further growth. Water both these potted plants at regular intervals so that they do not get dried. Observe and compare the growth of *Coleus* plants in both the pots for at least one month. Record the pattern of growth for each. *If possible, take photographs at regular intervals for comparison and affix them in the file.*

Draw your inferences from the table given below.

Precautions

1. The coleus plants taken should be of nearly same height and health.

2. The shoot tip should be removed with the help of sharp razor without injuring the other parts.

3. Observation for filling the table should be done for both the plants at the same time.

Observation Table :

S. No.	*Types of plant*	*Height*	*No. of Nodes*	*No. of Leaves*	*Number of buds appearing*	*No. of days*	
1.	Control plant	(i)	(i)	(i)	(i)	(i)	2 days
	with shoot	(ii)	(ii)	(ii)	(ii)	(ii)	4 days
	tip intact	(iii)	(iii)	(iii)	(iii)	(iii)	6 days
2.	Plant with	(i)	(i)	(i)	(i)	(i)	
	shoot tip	(ii)	(ii)	(ii)	(ii)	(ii)	
	removed	(iii)	(iiii)	(iii)	(iii)	(iii)	

ORAL QUESTIONS

Q. 1. *What is apical dominance ?*

Ans. The correlative inhibition of lateral buds by auxins from the apical bud is called apical dominance.

Q. 2. *What region of flowring plants is responsible for plant growth ?*

Ans. Growth in flowering plants is restricted to definite regions called *meristems.*

Q. 3. *Where is apical meristem located ?*

Ans. It is found at the root and shoot tips.

Q. 4. *What are the important features of the meristem ?*

Ans. The cells of the meristem remain unspecialized. They are large cells, with prominent nucleus and are capable of undergoing continuous division. From these cells after differentiation, other tissus of the plant cell take place.

Q. 5. *What happens if the tip of the shoot is removed ?*

Ans . Lateral branches appear.

Q. 6. *In which part of the plants auxins are produced ?*

Ans. They are produced in the apical region. Auxins are plant growth regulators.

Q. 7. *If you want to make a bush out of a plant which normally is not branched, what would you do ?*

Ans. To make a bush out of a plant, remove the shoot tip. It would allow the lateral branches to appear. As soon as the lateral branches are prominent, again remove their tips. The process is to be repeated with other branches. This would make a bush.

Q. 8. *Do the plants grow throughout life or in a fixed period in their life cycle ?*

Ans. Plants grow throughout life due to the activity of the meristem.

Q. 9. Name the hormone synthesized in root tip/shoot tip.

Ans. IAA (Indole Acetic Acid).

Q. 10. *Who introduced the term auxin ?*

Ans. THIMANN and SKOOG in 1933.

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INVESTIGATORY PROJECT 10

SOIL MICRO-ORGANISMS-I

CULTURE OF SOIL MICRO-ORGANISMS

Aim : To culture and study the micro-organisms present in the soil.

Material Required

Petridish, Potato, Slides, Agar, Coverslips, Dextrose, Microscope, Distilled Water, Methylene, Blue, Garden soil, Cotton blue, Flasks.

Introduction

Soil is the natural medium in which plants live, multiply and die and thus provide a perennial source of organic matter. Microbes living in soil recycle the dead organic matter (denitrification etc.) to be used by plants. The soil microbes include bacteria, actinomycetes, fungi, algae and some protozoans.

Garden soil is a good source of micro-organisms.

1. Preparation of Culture Medium

(i) Take 200 g of peeled potato chips. Boil them for fifteen minutes with 500 ml water in a big beaker. Squeeze the potato pulp thus obtained through a muslin cloth and keep it in a flask. Take 20 g agar in a beaker and warm it with 500 ml water. Mix both the solutions of potato and agar and add 20 g dextrose to it. Warm it for some time. In this way, one litre potato dextrose agar (P.D.A.) medium is prepared which is quite suitable for mycological technique (studies).

(ii) *Meat Extract Agar* : Weigh out 3g beef extract, 10g peptone, 5g NaCl and then combine with 1 litre of distilled water. Heat the mixture to 60°C, stirring until the materials are completely dissolved. Filter the above through cotton or filter paper and adjust the pH to 7.2 to 7.6 by adding a bit of sodium bicarbonate.

Now add 20g of agar to 1 litre of broth. Heat slowly until the agar is dissolved.

Procedure

(i) Pour P.D.A. or meat extract agar in 2 petridishes. Then autoclave at 15 pounds pressure for 15 minutes. Cover the petridishes.

(ii) Take 5 gm garden soil and divide it into two lots. Leave one lot untreated, but roast the other. After the roasted soil has cooled add it to one petridish containing nutrient medium and cover it. Add untreated soil to the other petridish containing P.D.A. or meat extract agar and cover it.

Leave these petridishes aside in a warm cupboard (Temp. 30-32°C) for a week. Then examine the petridishes.

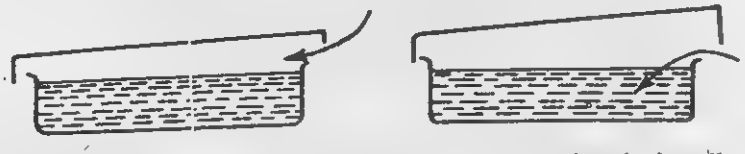

Fig. 10-1 : Investigating the presence of micro-organisms in the soil.

(iii) Now take 5 g of the given sample of soil and dissolve it thoroughly in 20 ml water in a beaker. Let the sand particles settle down. Then take 1 ml of this suspension and keep it on the nutrient medium. Keep it separately undisturbed for 2 days in optimum temperature. (This experiment may be performed when the atmospheric temperature is around 30-32°C).

(iv) After 2 to 3 days, observe under the microscope to see various microorganisms. Identify the microorganisms with the help of your teacher and draw their diagrams.

Observation

Colonies of microorganisms grow on the nutrient medium of the petridish in which fresh garden soil was added. These colonies appear as patches on the surface of culture medium. Roasting of the soil kills micro-organisms present in the soil.

Take a number of clean glass slides. Mark them. Take each slide and add a few drops of culture from one petridish. Observe the micro-organism you find. Draw a diagram of the micro-organisms present in this slides. Take the help of your teacher in identifying the micro-organisms. Ask your teacher which stain is to be used for different slides.

Make a list of the micro-organisms after identifying them.

Also take sample from the petridish in which roasted soil was added to the culture solution. Note your observations.

Precautions

1. Do not expose the contents of the two petridishes to the atmosphere.

2. Roast the soil properly for adding in one petridish.

3. Do not touch the culture with your naked fingers. Use dropper. Wear gloves.

4. Use proper kind of stains for different micro-organisms.

ORAL QUESTIONS

Q. 1. ***What are micro-organisms ?***

Ans. Micro-organisms, as the name suggests, are extremely small living beings which cannot be seen with naked eye. They are present practically every where.

Q. 2. ***Mention the various categories of micro-organisms.***

Ans. The major categories of micro-organisms are the following : Bacteria, Fungi, Algae and Protozoa. (Viruses also come under the category of micro-organisms but it is not possible to examine them in the school laboratory).

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INVESTIGATORY PROJECT 11

SOIL MICRO-ORGANISMS-II

STUDY OF SOIL LITTER-FAUNA

Aim : To study flora and fauna of soil.

Material Required

Petridishes, beakers, autoclave, glassware dissecting and compound microscope, slides, coverslips etc., garden soil, culture medium, Tullgren funnel.

Introduction

Organic matter (10%) is very complex part of soil. It is made by the rotting or decomposition of plant remains, animal manures and dead animals. Plant roots, rhizomes, leaves and stems are familiar materials that become soil organic matter. After they have reached rather a complete stage of decomposition, they are called *humus* or *organic matter* which acts as a sponge and helps in holding moisture in the soil. It loosens heavy soils and improves drainage. It also increases the infiltration rate (i.e., the rate at which water moves through the soil). The process of humus formation is called humification. Humus on complete decomposition is changed into CO_2, H_2O and minerals and this process is called mineralization.

Organic matter provides much of needed nitrogen and food for soil organisms and contributes to chemical action in the soil. A good supply of organic matter improves the condition and tilth of all soils. Dead leaves and stems lying on the surface of the soil, before they disintegrate, are known as litter. Litter's chemical nature and its amount depend upon the kind of vegetation, specially trees of the forest. The litter of trees comprise mainly of carbohydrates (cellulose and hemicellulose), lignins, fats, resins, waxes, etc. K, Ca, Mg, Mn, Si, Fe, Al, Cu, N_2 are the inorganic constituents of litter. Litter on the basis of its chemical and biological nature is divided into two types—*mor* and *mull*. The mor is non-porous and friable and does not have large earthworms and dominated by mosses and Ericaceae. The mull is porous, friable mass and have large earthworms with vegetation of geophytes. In thick forest, a thousands on tons of litter on the soil surface is accumulated each season. Just beneath the mesh litter *duff* is found which is derived from the preceding season's litter in which decay might have taken place. Bacteria, actinomycetes and fungi (the micro-organimsm) decompose the litter and result into *humus*. Micro-organisms, moisture, temperature, N_2 supply, soil pH and aeration influence the humus formation.

Practically all soils contain organic material derived from disintegration of plants such as dead leaves and rhizomes with a small addition from animal excreta or dead bodies.

Fauna

It is the animal population present in certain place or at a certain epoch. Soil fauna contains different types of big and small animals. Soil contains sufficient number of insects, round worms, centipedes, millipedes, flies, snails slugs, maggots, spiders, scorpions etc.

Procedure

1. Take a handful of garden soil. If the soil is in lamp, break it. Observe it carefully with the help of hand lens.

2. Select an area of soil with a thick layer of dead leaves (leaf litter) on the surface. A deposit from the floor of wood or beneath a hedge may be suitable. Collect equal quantities of topsoil (including the surface litter) and subsoil from two different places in the same area. You may use an empty tin bulb-cover or other implement for collecting the soil.

Break up the large lumps of soil so that animals can escape easily. Pile the soil on the sieve of the funnel in a heap to prevent rapid evaporation of moisture. Leave a clear gap all around the soil, between its edges and the wall of the funnel.

Place dilute Formalin in the collecting vessel to kill and also preserve organisms that enter it.

Switch on the lamp and leave it on for several hours.

Observation

When animals cease to emerge from the soil, examine the formaldehyde under a hand lens or microscope, and try to identify animals you see. For identification of animals, take help of the key

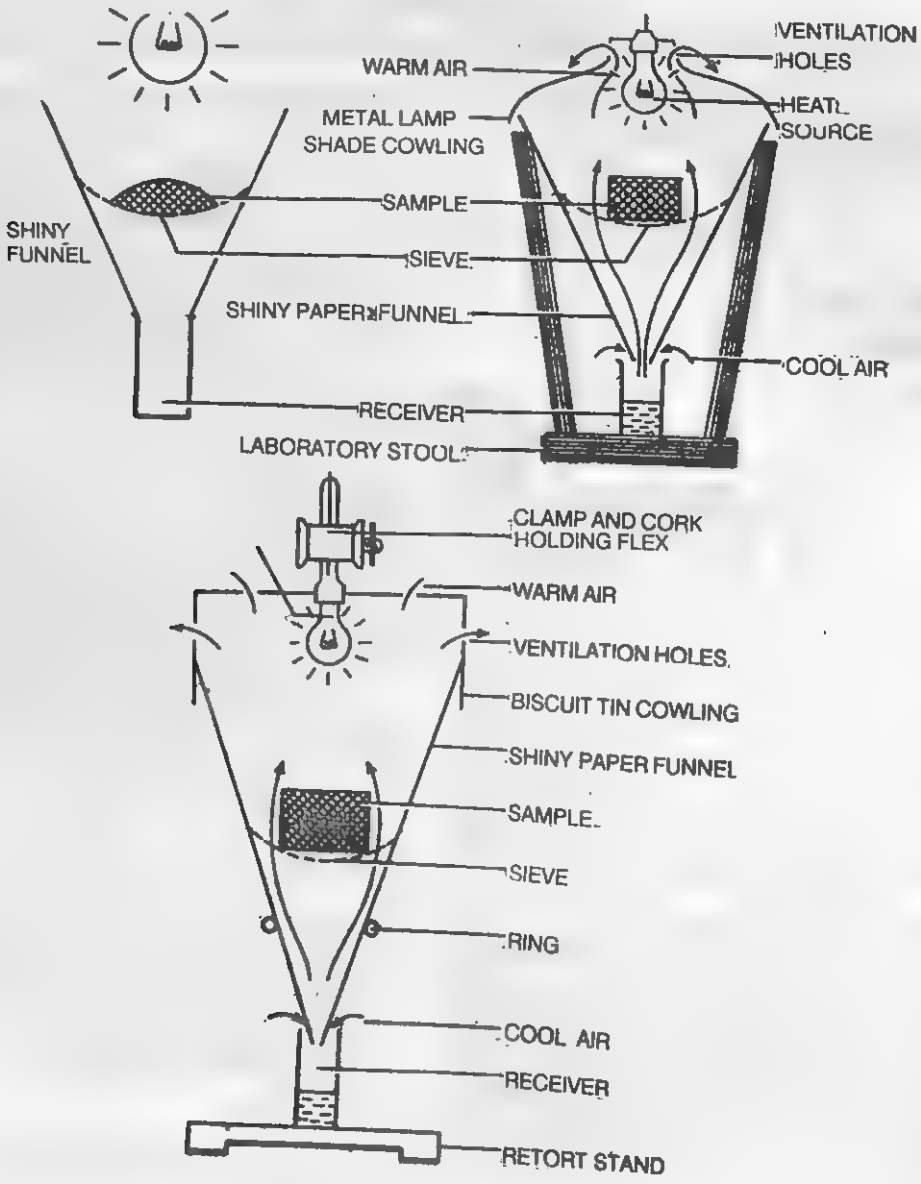

Fig. 12-1 : Designs of Tullgren funnels.

Table

S. No.	Characteristics of Organisms	Identification	Name of the organism	Habitat comment
1.				
2.				
3.				
4.				
5.				
6.				
7.				

given below and illustrations in appropriate books. Make a list of the various animals you discover in the soil.

IDENTIFICATION OF ORGANISMS

1. Observe the organisms with the help of hand lens. Note their characteristics.

2. On the basis of your observations identify and classify each one of them. Take the help of your teacher and the given diagram.

3. You may find some more organisms which are not shown in the diagrams here. Observe them. Make a list of them, identify and classify them. Write a few words about their habitats. Fill in the above table .

Precautions

1. Break up the larger lumps of soil to facilitate escape of animals.

2. Leave gap between the edges of the soil heap and the wall of the funnel.

3. If you see and can catch any animals in the soil litter, pick these out drop them into the liquid.

Take a sample of soil. Dissolve it in water. Stir it. Put a drop of water on a glass slide. Observe it under microscope. You may find different kinds of microscopic animals (protozoa, etc.). Identify them. Draw diagrams. Take the help of your teacher in the identification of micro-organisms.

ORAL QUESTIONS

Q. 1. *What is litter ?*

Ans . Litter is the partly decaying organic matter the dead and decaying parts of plants form the litter.

Q. 2. *What is the difference between litter and humus ?*

Ans . Humus is the dead organic matter which has reached complete stage of decomposition.

Q. 3. *What are phytophages ?*

Ans . Phytophages are plants or their parts that eat microbes.

Q. 4. *Is litter formation essential for the crop for replenishing minerals ?*

Ans. Yes.

Q. 5. *What do you understand by the term fauna ?*

Ans. It is the animal population present in a certain place.

Q. 6. *What do you understand by the term flóra ?*

Ans. It is the population of plants present in a certain place.

Q. 7. *Name a few insects that you may find in the soil.*

Ans . You may find a large number of insects in the soil. Some common ones are given below. Ants, white ants, varieties of mosquitoes, small flies beetles, springtails, small grasshoppers termites, insects, larvae, insect eggs. The insect population varies from soil to soil, and place to place.

Q. 8. *To which group snail and slugs belong ?*

Ans. They belong to mollusca.

Q. 9. *To which group scorpions, and spiders belong ?*

Ans. They belong to arthropoda.

Q. 10. *How do the micro-organisms obtain their food from soil ?*

Ans. Soil contains large amounts of organic matter from which these animals derive their food. They also take food from other organisms, plant material, dead, decaying leaves and also by eating other organisms. Some soil animals suck the sap of plants, flowers etc.

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INVESTIGATORY PROJECT 12

SPORULATION IN FUNGI

EFFECT OF LIGHT ON SPORULATION IN FUNGI

Aim : To study the effect of light on the formation of spores in fungi.

Material Required

Bread Pieces, Glycerine, Needle, Cotton blue, Petridishes, Microscope, Glass slides, Forceps, Cover slips.

Procedure

1. Preparation of Culture : Take three clean petridishes. Put a filter paper or cotton pad soaked in water in each petridish. Mark them A, B and C. Now, place a piece of bread in each one of them. Cover each petridish with another petridish. Put all these petridishes in a dark and warm corner of your laboratory. See that they remain moist all the time.

Observe them daily. After a few days, you may notice some white cotton-like mass appearing on them.

2. Preparation of Slide : Take a bit of white cotton-like mass from each bread piece and place it on separate slide under a drop of glycerine. Tease the thread-like mass. Add a drop of cotton blue. Cover it with coverslip. Examine each slide under the microscope.

You will see some fine thread like structures which are colourless. These are the hyphae mould (*Rhizopus/Mucor*). Draw their labelled diagram in your practical note-book.

Now, place petridish A in a dark corner, B in a place where diffused light is available and petridish C in bright light. Observe them daily.

Observation

Note down in which petridish A, B or C black patches appear first. Take a bit of black cotton-like mass and prepare a temporary slide. Examine it under a microscope.

You will observe globular structures at the end of short filaments. These are **sporangia.** A few of them will be found to have burst open, throwing out extremely small structures called spores.

Sporulation in Fungi (Mould-Mucor)
Inference : Sporulation in fungi (mould) occurred first in the bread placed in petridish. Therefore, light affects sporulation in fungi (moulds).

Note : 1. You can do this experiment by taking example of mushroom. Mushrooms are very

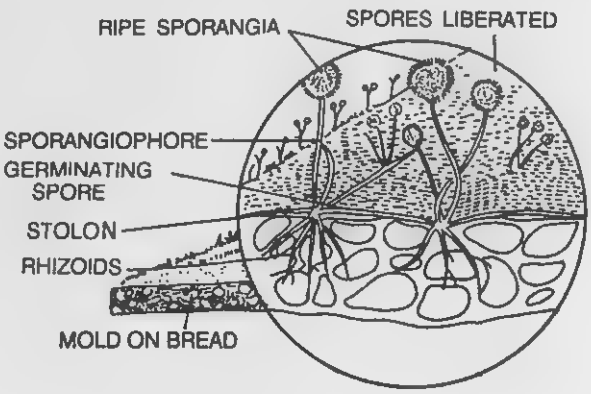

Fig. 12·1 : Mucor growing on bread.

common during rainy season. Select some young mushrooms in which caps are not yet formed. Collect them along with substratum on which they are growing. Place them in moist sawdust. Divide them into three groups and place them in dark, diffuse light and bright light.

After sometime caps will appear. These caps, called **pileus**, are spore-producing bodies. Observe a number of radiating membranes on the ventral surface of the cap. These membranes bear spores on either side. On maturation spores disperse from the **gills** or **lamellae**. You can note down the maturation time in various light conditions to study the effect of light on sporulation in fungi.

2. You can also study the effect of various wavelengths of light (Red, blue etc.) by taking table lamps and covering them with cellophane paper of different colours.

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INVESTIGATORY PROJECT 13

A PLANT PARASITE

STUDY OF CUSCUTA AND ITS ADAPTATION FOR PARASITIC MODE OF LIFE

Aim : To study the structure of a parasitic flowering plant (Cuscuta) and to know its parasitic adaptations.

PARASITE

Any organism that lives on or in the body of any other organism and absorbs necessary food materials, wholly or partially, from it is termed as a **Parasite.** Usually the parasite is smaller in size as compared to the organism on which it lives. The organism on which it lives is termed as **host.**

Parasitism is found both in animals and plants. Among the flowering plants there are different degrees of parasitism. Some are total parasites and others are partial parasites. Total parasites are non-green in colour because they do not manufacture their food by photosynthesis. On the other hand, the partial parasites are green in colour because they also manufacture their own food by photosynthesis. *Cuscuta* is a total parasite.

EXPERIMENT

To study the Cuscuta and to know its structural adaptation for parasitic mode of life.

Material Required

A twig of plant with cuscuta parasite, microscope, razor, saffaranin stain, glycerine, glass slide, cover slip, forceps.

Procedure

Visit your school garden. Observe various flowering plants. You may observe on some bigger perennial plants (hedges, trees etc.) yellow thread like structure growing very profusely. This yellow cylindrical thread like structure is Cuscuta plant. Though it is also a flowering plant, it lives and derives its nourishment from the host. Being a total parasite, it does not manufacture its own food by photosynthesis. Hence it does not possess chlorophyll (non-green). Obtain a twig of a host plant on which *Cuscuta* stem is twining around.

Cut a thin section of the twig along with the Cuscuta stem with the help of a sharp razor. Take care that sections should be cut from the place where Cuscuta plant is attached or appears to enter in the stem of host.

Place these sections in a watch glass containing water. With the help of a brush select a few thin sections. Place one by one on a glass slide in a drop of water. Stain them with saffaranin stain. Remove extra stain by washing them in water. Now examine each section under the compound microscope after putting it on a drop of glycerine on the slide. You may find many sections which show normal anatomy of the host's stem. In some sections you may find some abnormal structure—cuscuta's tissues—entering into the stem of the host after breaking its epidermis. The Cuscuta's tissues entering the host is in fact the parasitic roots called **haustoria.** The haustoria are in fact the modified advantious roots of Cuscuta. Observe the haustoria tissue and the conducting tissue of the host stem. Observe how the haustoria have established intimate concact with the conducting tissue of the host.

Haustoria of *Cuscuta* absorb water, minerals

and food from the conducting tissue of the host as much as they require.

Note : If you are unable to collect *Cuscuta* (dodder) parasite, ask your teacher to provide you with a permanent prepared slide and also its preserved specimen.

Parasitic Adaptations. Refer Oral Question Number 1.

ORAL QUESTIONS

Q. 1. *Give parasitic adaptations of Cuscuta.*

Ans. (i) It is non-green, because it does not manufacture its own food by photosynthesis.

(ii) It does not bear leaves, because they are not needed for the manufacture of food.

(iii) Absense of leaves also helps in peventing transportation.

(iv) The stem is twisting, cylindrical which easily climbs on the host plants.

(v) It has specialized 'roots' haustoria which enter the body of the host, establish contact and draw water, minerals and food material from the connecting tissue of the host plant.

(vi) Cuscuta is a total parasite.

Q. 2. *What is a total parasite ?*

Ans . Total parasite is that parasite which draws its total food from the host and also lives totally on the host's body.

Q. 3. *What are the other common names of Cuscuta ?*

Ans . It is also called as dodder, swaran lata, and akashbel.

Q. 4. *Name any other stem parasite.*

Ans. Viscum (Mistletoe).

Q. 5. *Name some root parasites.*

Ans. Orobanche Bania Bau, Sarson-Banda and Balanophora.

Q. 6. *Is Mistletoe a total stem parasite ?*

Ans. No. It is a partial stem parasite.

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INVESTIGATORY PROJECT 14

GIBBERELLIN AND GROWTH

STUDY OF THE EFFECT OF GIBBERELLIN ON GERMINATION AND SHOOT ELONGATION

Introduction : Germination, and awakening of the dormant embryo is an irreversible process. For germination, the seed must be viable, non-dormant and be placed in a favourable environment i.e suitable water (moisture), aeration, temperature and light.

Gibberellin (or gibberellic acid = GA) a plant hormone was first identified in studies of a disease of rice plants, the *bakanae* (foolish seedling) disease caused by the fungus *Gibberella fujikuroi*. Gibberellin may show many effects on plant growth and development aush as : internode elongation, inducing flowering, breaking of bud and seed dormancy, increasing seed germination, weaken apical dominance, induction of parthenocarpy, etc.

More than 50 gibberellins are known but the common feature of all of them is *gibbane ring skeleton* and whose biological action is known to have a powerful stimulation of growth (cell elongation/cell division or both) of certain dwarf mutants.

EXPERIMENT 1

Aim : Study of the effect of gibberellin on seed germination.

Material Required

Student's Requirements : Record file, pencil, sharpener, eraser, a ruler.

Laboratory's Requirements : Seeds (purchase from NSC, Delhi), gibberellic acid solution (100mg/litre; dissolve GA in 1—2 ml of 95% ethanol and dilute to 1 litre with water), solutions of different GA concentrations (10 ml of each solution) :

GA 10^{-1}M (.01 × g mol. wt. of GA dissolved in 1 ml of ethanol and diluted to 100 ml with water).

GA 10^{-2} M (1ml 10^{-1}M GA diluted to 10 ml with water)

GA 10^{-3} M (1ml 10^{-2}M GA diluted to 10 ml with water)

GA 10^{-4} M (1ml 10^{-3}M GA diluted to 10 ml with water)

GA 10^{-5} M (1ml 10^{-4}M GA diluted to 10 ml with water)

1000 ml distilled water containing 1—2 ml 95% ethanol, vermiculite or sand, seeds boxes or trays, pots, beakers, micropipette, measuring cylinder, automizers, eye droppers.

Method

Soak seeds of desired variety in different concentrations of gibberellic acid filled in beakers. Atleast 10 seeds should be soaked in each of the gibberellic acid concentration and 10 seeds in distilled water (control set). Remove the seeds and place them in different trays (or petridishes) filled

Molecular weight of GA = 346;
Use either separate pipettes while preparing each concentration of GA or rinse it thoroughly with distilled water.

with vermiculite or sand (or lined with moisten filter papers). Keep them in dark. Observe the seeds of each petridish for radicle emergence. Make up your mind to consider particular radicle length (say about 3 mm) as criterion for seed germination. Note daily, how many seeds germinate in each concentration and present your data in tabular form. This you can repeat for different varieties.

Observations

Gibberellic acid increases germination percentage. Find out which concentration has minimum and maximum effect. Moreover, which variety is affected and which is not. You will observe different germinations percentage in different varieties and in different concentrations.

Table 14.1
Effect of gibberellin on seed germination percentage

Gibberellin concentration	*Seed varieties*
0 (Control)	
10^{-1}M	
10^{-2} M	
10^{-3} M	
10^{-4} M	
10^{-5} M	

Conclusion :

Effect of gibberellin on seed germination is not only concentration dependent but also varietal dependent.

EXPERIMENT 2

Aim : Study of the effect of gibberellin on shoot elongation.

Material Required

Student's Requirements : Same as mentioned in Experiment 1.

Laboratory's Requirements : Same as mentioned above for experiment 1.

Method

Soak and plant pea seeds (different varieties : dwarf and long) in seed trays filled with vermiculite or sand and grow until they achieve 50 mm length. About 20—30 seeds are planted per tray and a total of 6 trays are required per variety. Measure their initial height (about 50 mm tall) from soil level. Now allow 10 plants (of same vigour) to grow in each tray while removing others.

Label the trays and apply one drop of the alcoholic solution on the centre of the leaflet of true leaf of each seedling mentioned as follows :

(1) alcoholic water solution (Control)

(2) alcoholic GA 10^{-1}M solution

(3) alcoholic GA 10^{-2} M solution

(4) alcoholic GA 10^{-3} M solution

(5) alcoholic GA 10^{-4} M solution

(6) alcoholic GA 10^{-5} M solution

This all is only for 1 veriety. You follow the same pattern for other varieties also. Plants of each tray should be applied with these solutions as well as measured for different characters after 1, 2, 3, 4 and 5 weeks from the start of experiment. The parameters may be total height of plants, length of internodes, length and width of leaves, and fruit length. Besides this you can also see for initiation for flowering, fruit and seed setting, flower size, petal size, etc.

You can also perform this experiment with other small plants like marigolds (*Tagetes*), zinnias, sweet pea (*Lathyrus*), snapdragons (*Antirrhinum*), etc.

Observations and Discussion

Calculate the average length and other attributes for each treatment and variety. Relate the effect produced to each concentration over control. Illustrate your data with table and graph (concentration at X axis and increase in length on Y axis).

Conclusion

Gibberillin has its maximum effects on shoot elongation.

ORAL QUESTIONS

Q. 1. *Do you know any hormone other than gibberellin which may induce seed germination?*

Ans. Yes. It is ethylene.

Q. 2. *Is there any hormone which retards seed germination ?*

Ans. Yes. It is abscisic acid.

Q. 3. *What is phytochrome ?*

Ans. It is photoreversible pigment (protein).

Q. 4. *What is the effect of gibberellic acid on shoot elongation ?*

Ans. Gibberellic acid causes elongation of shoot.

Q. 5. *Identify the effect of which hormone is being displayed in following photograph.*

INVESTIGATORY PROJECT 15

HERBICIDES AND WEEDS

EFFECT OF HERBICIDE ON A LAWN WITH WEEDS (TO COMPARE THE EFFECTS ON MONOCOTYLEDONS AND DICOTYLEDONS)

Introduction

Weeds are unwanted and undesirable plants which interfere with the utilization of land and water resources. Weeds compete with crop plants for nutrients, soil moisture and sunlight. The intensity of weed competition depends upon (i) type of weed species, (ii) severity of infestation, (iii) duration of weed infestation, (iv) competing ability of crop plants and (v) climatic conditions which affect weed and crop growth. Depending on the degree of competition, weeds reduce the crop yield. Weeds may be divided in three groups : annuals, biennials and perennials. In each group, there are both broad leaf weeds (dicot weeds) and grasses (monocot weeds). There is a long list of herbicides but some common ones are delapon (aliphatic), AMA (arsenical), TIBA, medipham, 2, 4-D, amitrole, etc. Herbicides affect different physiological and biochemical processes such as respiration and mitochondrial activities; photosynthesis; protein and nucleic acid metabolism; and hydrolytic enzyme activities.

EXPERIMENT 1

Aim : To observe the effect of herbicide on a lawn with weeds (to compare the effects on monocotyledons and dicotyledons).

Material Required

Student's Requirements : As mentioned in

Laboratory's Requirements : 2, 4-D, large containers (cans), measuring cylinders.

Method

Generally a lawn may have development of certain broadleafed plants which wark as weeds. These broad leafed plants may be *Ageratum conyzoides, Amaranthus virids, Anagalis arvensis, Bidens pilosa, Borreria hispida, Celosia argentia, Chenopodium album, Convolulus arvensis, Euphorbia hirta, Phyllanthus niruri, Polygonum plebejum, Portulaca oleracea, Sonchus oleraceus,* etc. All these plants are generally not associating the lawn simultaneously. Prepare solution of 2, 4-D or 2, 4-5-T (2.2 Kg/ha) and spray to the lawn fortnightly. Observe the effects. Represent your data in tabular form to show the effects of herbicide.

Observations

You may observe that some of the broadleafed plants are reduced and show great injury. Some plants may totally disappear.

Conclusion

This all happens because 2,4-D works as an herbicide to broadleafed plants rather than to kill narrow leafed plants (constituent plants of lawn).

ORAL QUESTIONS

Q. 1. *What is placement of herbicide ?*

Ans. Herbicides are applied either to soil or foliage.

Q. 2. *Name the various methods to control the weeds.*

Ans . (i) Mechanical (tillage, hoeing, hand picking, digging, cheeling, moving, burning, floodi mulching, etc.)

(ii) Biological (crop rotation, crop competition; parasites, predators and pathogens).

(iii) Chemical (2, 4-D, MH, Atrazine, Simazine, etc.)

Q. 3. *Why 2, 4-D is used in higher concentrations in the lawns ?*

Ans. 2, 4-D in high concentration serves as weed killer especially dicotyledons. Howeve monocotyledons (grasses) when sprayed with this, are not inhibited. This is why, this compound is used i eradicating dicotyledonous weeds.

Q. 4. *What are the major categories of time of herbicide application ?*

Ans . Preplanting, pre-emergence and post-emergence in relation to crop and weed.

□ □

INVESTIGATORY PROJECT 16

CANOPY ARCHITECTURE

Aim : To study the canopy architecture of trees.

Every biotic community has a vertical layering (**stratification**) of organisms or environmental conditions. In a grassland community, we can recognise three strata—

(i) The **subterranean stratum** is represented by organisms embedded in soil e.g., bacteria, fungi, protozoans, spiders, nematodes, earthworms and other invertebrates; and by underground plant parts such as roots and rhizome.

(ii) The **floor substratum** is represented by rhizomes of grasses, insects, spiders, reptiles and rodents.

(iii) The **herbaceous stratum** is represented by herbs, insects, birds and grazing animals.

In a **forest community**, following five vertical strata are recognized :

(i) **Overstory stratum** is represented by trees more than 40 feet in height.

Fig 16-1 : Stratification in a tropical rain-forest. I. Trees more than 50 m in height. II. Dense community of tall trees. III. Community of shorter trees. IV. Shrubs. V. Herbs and the leaf litter mixed with the decomposers (fungi and bacteria).

(ii) **Understory stratum** has trees upto 20-30 feet tall.

(iii) **Transgressive stratum** has plants between 4—20 feet in height.

(iv) **Seedling stratum** has plants of smaller heights from soil level upto 4 feet.

(v) **Subterranean layer** has large amount of humus extending from surface upto of 2-3 metres.

The type of animals vary in each layer, however, most animals can easily move from one region to another in search of food *e.g.*, insects, snails, birds and squirrels. The animals on soil surface include snakes, some birds, insects, wolves, rabbits and deer. The animals living in humus are beetles, fly larvae, centipedes, mites, spiders, annelids, protozoans and nematodes.

ORAL QUESTIONS

Q. 1. *Define a biotic community.*

Ans . A naturally occurring assemblage of plants and animals belonging to different species which live in the same environment constitute a biotic community.

Q. 2. *Name a few forest trees.*

Ans . *Pinus*, Neem, Banyan tree, Fig tree, Gold mohar, *Acacia*, Rubber tree etc.

Q. 3. *Name different types of forests seen on our planet—earth.*

Ans. Tropical evergreen forests, Tropical deciduous forests, Temperate deciduous forests, coniferous forests (taiga), Grasslands, Deserts etc.

Q. 4. *What is the total forest area in India ?*

Ans . In India, the forests are spread over to 17.2 per cent of the total geographical area of the country.

Q. 5. *Define forestry.*

Ans . Forestry can be defined as the branch of knowledge concerned with scientific rearing of tending of forest trees in order to derive the maximum benefit from them.

Q. 6. *What do you mean by a canopy ?*

Ans . Canopy means the top most layer of a forest.

□□

INVESTIGATORY PROJECT 17

AVENUE TREES AND TEMPERATURE

Aim : To study the effects of avenue trees on temperature.

Materials Required

Maximum and minimum thermometers, note book, pencil, scale etc.

Procedure

1. Select an avenue (an area where trees are especially planted) either in your school or a nearby road. Fix maximum-minumim thermometers at various heights say 1 metre, 3 metres and 5 metres above the ground level under the trees and also in exposed nearby areas (without trees).

2. Note the temperatures of the day in all the exposed and tree covered areas and record them in the observation table.

Observation Table

Maximum and minimum temperatures of the day in avenue and exposed areas.

Results

The temperatures in all the avenues will be quite less as compared to the corresponding exposed areas at all levels above the ground.

Explanation

Trees have a profound effect on the local climate and weather of a place. It is due to two main reasons : (i) trees make shade on the ground so that sunlight does reach below the trees; and (ii) due to transpiration, some moisture is always present in the vicinity of the trees. Therefore, temperature around trees is low as compared to other nearby places where trees are not planted.

Date of recording the temperatures

Height above the ground level	*Temperature (°C)*			
	Avenue area		*Exposed area*	
	Maximum	*Minimum*	*Maximum*	*Minimum*
1 metre				
2 metres				
3 metres				

ORAL QUESTIONS

Q. 1. *What is an avenue tree ?*

Ans. Any road-side tree especially planted is an avenue tree.

Q. 2. *Name a few avenue trees.*

Ans. Peepal, mulberry, ber, jamun, banyan tree etc.

Q. 3. *What is the significance of avenue trees ?*

Ans. Avenue trees help to increase the moisture contents of an area, reduce the temperature and also help in soil erosion.

Q. 4. *What characters of a tree should be considered before they are planted on the road-sides ?*

Ans. (i) They should have a dense foliage to give shade.

(ii) The lower brancehs of a tree should not be less than 3-5 metres so that they do not obstruct the traffic.

(iii) They should have a shallow but deep root system.

(iv) They should not have any hanging aerial roots.

(v) Trees should be of evergreen type.

(vi) Trees should not be thorny.

Q. 5. *What term is used for planting of trees on a large scale ?*

Ans. Afforestation.

□□

INVESTIGATORY PROJECT 18

TRANSLOCATION PROCESS IN PLANTS

STUDY OF THE EFFECT OF 2,4–D ON TRANSLOCATION

Aim : To study the effect of 2, 4-D on translocation process in plants.

Material Required

Potted Hollyhock or China rose plants, Potato tubers, Knife, Ethanol, Beakers, Spray pump, 2, 4-D.

Herbicides : Chemicals used to kill weeds, that is unwanted plants are called herbicides. 2,4-D is one of the herbicides and its salts, esters and acids are soluble in water, oil and in organic solvents. 2,4-D is available as water-soluble salts, oil-solube amine and emulsifiable acid.

Procedure

Prepare 0.05 per cent aqueous solution of 2,4-D. Weigh 50 mg 2,4-D and dissolve it in 5 ml ethanol. Add this solution in 100 ml water drop by drop, stirring vigorously. Similarly, you can prepare solutions of 2,4-D of various strengths. Concentrated solution of 2,4-D kills plants with broad leaves. Observe them daily.

1. Take four hollyhock or china rose potted plants. Mark the pots A, B, C and D. Remove 2" wide bark including phloem from the main stem of each one of them.

2. Now prepare aqueous solution of 2,4-D of various concentrations, for exmaple, 0.05 per cent, 0.1 per cent, and 0.5 per cent . You can also use 2,4-D solutions of other concentrations. High concentration of 2,4-D kills dicotyledon plants. Spray plain water on plant in pot A; 0.05 per cent 2,4-D solution on plant in pot B; 0.1 per cent 2,4-D solution on plant in pot C; and 0.5 per cent 2,4-D solution on plant in pot D. Place the plants in similar conditions of light and temperature.

Observations

(i) You will observe that a swelling above the ring appears in each plant. Measure the swelling in each plant and find out in which plant swelling is more. Fill up the following table.

(ii) To study the effect of 2,4-D on translocation, you can raise potato plants from

Table

S. No.	*2,4-D sol.*	*Measurement of swelling*			
		A	*B*	*C*	*D*
1.	0.05 per cent				
2.	0.1 per cent				
3.	0.5 per cent				
4.	Nil (Control)				

potato tuber of the same variety and almost of the same size. Keep a group of potato plants (2 or 3 plants) as control and on others spray 2,4-D aqueous solution of various concentrations.

2,4-D interferes with the translocation of carbohydrates (sugars) from leaves. In potato tuber plants, carbohydrates are synthesized in green leaves and translocated to underground potato tubers where they are stored.

Spray 2,4-D solution when potato plants are mature and formation of tubers sets in.

Observation

Collect the yield of potato tubers from both types of plants—control plants and plants treated with 2,4-D solution.

(A) Count the total number of potatoes produced by the following :

(i) Control plants

(ii) 2,4-D treated plants

(B) Size of potatoes produced by the following:

(i) Control plants (Take average size)

(ii) Treated plants (Average size)

(C) Average Weight of the following :

(i) Control plants

(ii) Treated plants

Difference.....

Inference : Write down inference on the basis of your observations.

ORAL QUESTIONS

Q.1. *What is the full form of 2,4-D ?*

Ans. 2,4-D dichlorophenoxy acetic acid.

Q.2. *In what way 2,4-D affects translocation ?*

Ans. 2,4-D interferes with the sugar transport from leaves to stems and roots.

□□

INVESTIGATORY PROJECT 19

EFFECT OF POLLUTION ON ROADSIDE PLANTS

STUDY OF PARTICULATE MATTER COLLECTED BY THE FOILAGE OF ROADSIDE TREES

Aim : To study the particulate matter deposited on the foliage of various species of roadside trees.

WHAT IS PARTICULATE MATTER ?

The particulate air pollutants get deposited on the foliage of plants. The particulate air pollutants include dust, potassium salts, flourides, sodium chloride, agricultural chemicals, smoke and lead. In urban areas where automobile and industrial exhausts are more, there is significant deposition of lead on the trees. Chief source of lead pollutant is **tetraethyl lead** used as an antiknock additive in fuels of vehicles. Lead gets deposited in the tissues of plants (leaf) and also in the tissues of human body. Lead deposition in tissues, even 0.2 parts per million concentration causes metabolic disturbances.

Experiment

(i) To observe the particulate matter under the compound microscope.

(ii) To compare the amount of particulate matter collected by the foliage of various species of roadside trees.

(iii) To test the presence of lead particulate pollutant.

Material Required

Leaves of road-side trees, Brush, Slides, Microscope, Dilute hydrochloric acid, Potassium chromate sol., Potassium iodide sol., Beakers, Test tubes.

Procedure

(i) Collect sufficient number of leaves of various species of road-side trees. Weight them and note down their weight. Wash the leaves of each species with equal amount of water and collect the wash. Again weigh the leaves and find out the difference in weight.

You may weigh the washings of leaves of each species and find out the difference in weight of water taken and the wash obtained.

(ii) With the help of brush, collect particulate matter from a leaf of roadside tree. Place it on the slide and examine it under the microscope.

(iii) Take about 5ml of the wash obtained in experiment (1) in a test tube. Shake well before pouring it into the test tube. Add dilute hydrochloric acid to it. If precipitate appears, filter the precipitate and collect the filtrate. Divide the filtrate into two parts.

1. To part I add potassium chromate solution.

2. To part II add potassium iodide solution.

Similarly, test the wash of leaves of each species for lead.

Observations

(i) Note down your observations in the following table :

S. No.	Name of road-side tree	No. of leaves taken	Wt. of leaves before wash	Amount of water taken for wash	Wt. of leaves after wash	Wt. of wash	Difference in Wt. of leaves/ wash.
1.							
2.							
3.							
4.							
5.							
6.							

(ii) Observe the colour and size of the particulate matter.

Note down the difference, if any.

(iii) 1. On addition of potassium chromate, if yellow precipitate appears, it confirms the presence of lead (Pb^{2+}).

2. Appearance of yellow ppt. on addition of potassium iodide confirms the presence of lead (Pb^{2+}).

Note: (i) You can select six different plants of the area for your experiment.

(ii) You can also place six potted plants or six plants growing near a busy road for your experiment.

(iii) Repeat you experiments at regular intervals.

(iv) Also take into account, the dust, and other material collected on the surface of leaves.

(v) Identify various types of particulate matter on the surface of the leaves. Correlate the material found on the leaves with the area in which they are found.

ORAL QUESTIONS

Q. 1. *Name four particulate pollutants which you think can be collected by foliage of plants.*

Ans . Dust, lead, agricultural chemicals (insecticides, herbicides, pesticides etc.) and fly-ash.

Q. 2. *What air pollutants do you think can be more in an urban city ?*

Ans . Carbon monoxide, sulphur dioxide, nitrogen oxide, hydrocarbons, particulate lead compounds.

Q. 3. *In what way lead pollutant is harmful to man ?*

Ans . Lead pollutant gets deposited in the tissues and creates disturbance in metabolic processes.

Q. 4. *What are the major sources of air pollution in urban areas ?*

Ans . Automobiles, burning of fossil-fuels (coal), industries.

□□

INVESTIGATORY PROJECT 20

POLLINATION

POLLINATION IN SUNFLOWER AND PEA-FLOWER

Aim : To study the importance and mechanism of pollination in sunflower and pea-flower.

WHAT IS POLLINATION ?

Pollination is defined as the process of transfer of pollen grains from the anther to the stigma. When the pollen grains are transferred from the anther to the stigma of the same flower or another flower on the same plant it is called **self-pollination or autogamy.**

Flowers are adapted in different ways to ensure either self- or cross-pillination. Self-pollination is possible only in monoecious plants or in those bearing hermaphrodite flowers (bearing both the sex organs) in which the sex organs attain maturity almost simultaneously. In unisexual flowers cross-pollination becomes obligatory. However, in bisexual plants various devices are present to prevent self-pollination and promote cross-pollination.

When the pollen grains are transferred from the anther to the stigma of flowers on another plant of the same or a different species it is called **cross-pollination or allogamy.**

EXPERIMENT 1

Pollination in Sunflower

Material Required

Razor or Blade, Insect net, Hand lens, Sunflower, Forceps, Glass Slide, Microscope, Coverslip, Glycerine, Dissecting Microscope, Water.

Procedure

Select a sunflower. Cut it into two equal halves by a longitudinal cut passing through the centre. Observe its **florets—both ray florets** and **disc florets** with the help of a hand lens. Remove a ray floret with the help of forceps and examine it under the compound microscope.

Cut a cross-section of the ovary of a ray floret. Prepare a temporary mount of it and examine under the microscope.

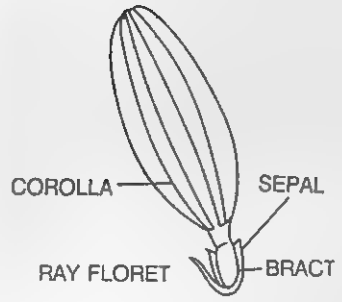
Take out a disc floret occupying the outer part of the head, adjacent to ray florets. Cut a longitudinal section. Observe the form of corolla (tubular), position and height of stamens, long style with two stigmas, ovary with ovule.

Remove a disc floret (young one) from the central part of the head. Observe the stamens, anthers, short style, pressed stigmas. With the help of a hand lens, observe the slit formed on the inner side of anthers and fallen pollen grains on the non-receptive surface of the stigma.

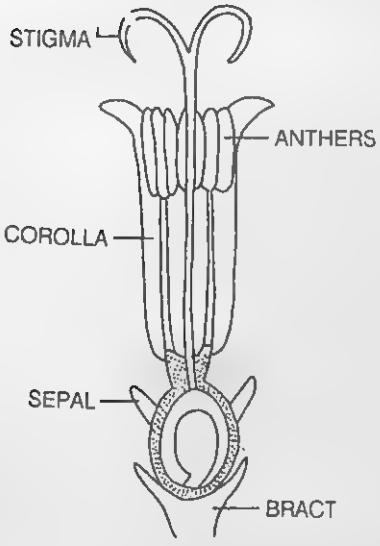
Visit the garden and observe the insects which visit sunflower head. Trap a honey bee or a butter fly, sitting over a sunflower, with the help of an insect net and bring it to your school laboratory for observation.

Observations

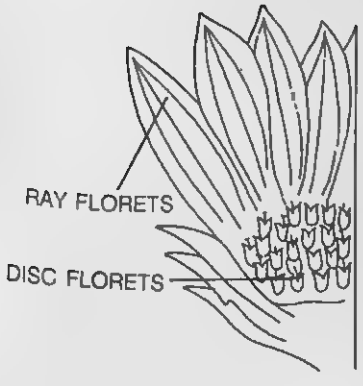
The sunflower is a compound flower—inflorescence—in which a large number of small flowers, called florets, are crowded together into a



(a)



(b)



(c)

Fig . 20·1 : Sunflower. (a) Ray floret, (b) Disc floret, (c) Part of a vertical section through capitulum.

head or **capitulum** surrounded by a number of overlapping sepal-like bracts.

The florets have no sepals but bear two small scales. Florets are of two types:—(i) *Ray florets* and (ii) *Disc florets.*

(i) Ray florets. These florets are found nearer the outer part of the head. Ray florets have brightly coloured, strap-shaped corollas. Their ovaries do not contain ovules. Stamens are absent. Ray florets function only as organs of attraction for insects.

(ii) Disc florets. These are found on the inner part of the head. They are specially adapted for pollination. Their corolla is tubular and consists of five petals. Stamens are five. Their anthers are joined together at the edges, forming a tube-like structure and style, a condition known as **syngenesious.** The ovary consists of two fused carpels containing only one ovule. The style is long with two stigmas. The nectary lies at the base of the style.

Pollination Mechanism

Sunflower is **protandrous** i.e., the stamens mature before the stigmas.

In the young disc florets, the anthers split along their inner sides, so that the pollen is shed into the tube formed by the anthers.

Fig. 20·2 : Leg of Honey Bee.

Pollen grains can be observed with the help of the lens on the non-receptive surface of the stigma. In young disc florets, the short style below the pollen tube and the receptive surfaces of the two stigmas are pressed together so that pollen grains of the same flower cannot reach them.

Later, in older disc florets, the style elongates, pushing the pollen out of the anther tube. And the stigmas open out to expose the stigmatic (receptive) surfaces. By the time the central young ones have reached the stage where only the pollen grains are released, the older disc florets (outer ones) have already got their stigmas above the stamens and their stigmatic surfaces are exposed.

The honey-bee, causes pollination in the sunflower. It receives pollen all over its legs and under-surface as it walks outwards. You might have observed pollen grains on the legs and under-surface of the bee with the help of hand lens. When the bee reaches the older flowers, the pollen grains (obtained from other flower heads) from its body are spread on the exposed stigmatic receptive surface and **cross-pollination** is effected.

If cross-pollination fails, the stigmas curl around to pick up their own pollen grains and secure **self-pollination.**

Inference. The sunflower has the following adaptive mechanism for pollination.

Adaptations for Cross-Pollination by Insects

(i) Ray florets have coloured petals to attract insects (e.g. bees).

(ii) At the base of the style, nectaries are present which produce nectar.

(iii) Disc florets are protandrous. Thus, self-pollination is prevented.

(iv) On maturity, the style elongates and the stigmatic surface comes to lie above the anther tube. Thus, self-pollination is prevented.

Adaptation for Self-Pollination

When cross-pollination fails, the stigmas curl around to pick up their own pollen grains to ensure pollination.

EXPERIMENT 2

Pollination in the Sweet-pea Bush (*Crotalaria*)

Procedure : Obtain the flowers of the sweet-pea bush. Cut a vertical section of the flower and study the structure and placement of sepals, petals, stamens and gynoecium.

Observe the flowering sweet-pea plant and find out the insects that visit it. Try to observe closely, if you find a honey bee on the flower.

Observations

The flower of *Crotalaria* consists of 5 green sepals, the two upper ones being large. Sepals are joined together to form the calyx. Corolla consists of 5 petals. The posterior petal called **standard,** is large, the two lateral ones are known as **wings;** two anterior ones unite to form a boat shaped structure known as **keel.**

Within the keel are ten stamens joined in the middle by **filaments.** Inside this filament tube nectar is secreted from the nectary.

Gynoecium is monocarpellary and consists of a long style bent upwards roughly at right angle and bears the hairy stigma.

In *Crotalaria,* pollination is carried out by the honey bee. The bee is attracted by the conspicuous standard. It lands on the wings of the flower, which are depressed, thus depressing the keel. A slight downward pressure on the keel forces the thickened ends of the outer filaments further into the tube and squeeze a ribbon of pollen on to the under-surface of the bee. When the bee tries to reach the nectar, the stigma rubs against it and receives **pollen from flowers previously** visited by the bee. In this manner cross-pollination takes place in *Crotalaria.*

Inference : The sweet pea (*Crotalaria*) flower has following adaptations for cross-pollination :

(i) Brightly coloured petals (standard).

(ii) Nectary for the production of nectar.

(iii) Stigma becomes receptive.

ORAL QUESTIONS

Q. 1. *What is pollination ?*

Ans . Transfer of pollen grains from stamens (anthers) to the stigma of the same flower or another flower of the same species is called pollination.

Q. 2. *What is self-pollination ?*

Ans . Transfer of pollen grains from the anthers (stamens) to the stigma of the same flower or another flower on the same plant is called self-pollination.

Q. 3. *What is cross-pollination ?*

Ans . Transfer of pollen grains from the stamens (anthers) to the stigma of other flower through any agency such as air, water, insects, birds or other animals including man is called cross-pollination.

Q. 4. *What device the sunflower has for cross-pollination ?*

Ans. Refer to inference of the experiment.

Q. 5. *What mechanism the sunflower has to ensure piolination if the cross-pollination does not occur ?*

Ans. Refer to point V given in the inference of the experiment.

Q. 6. *Name the insects which usually effect the pollination in the sunflower.*

Ans. Generally, honey-bee and some species of butterflies.

Q. 7. *What adaptation Crotalaria flower has for cross-pollination ?*

Ans. Refer to inference of the experiment (ii).

Q. 8. *Which is better—self-pollination or cross-pollination ?*

Ans. Cross-pollination is better because it provides more chances of variation and evolution of better individuals of a species.

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INVESTIGATORY PROJECT 21

FLOWER COLOURS

STUDY OF FLOWER COLOURS IN THE GARDEN

Aim : To observe the plants in the garden in various seasons and to find out the flowering season and colour of their flowers.

WHAT MAKES FLOWERS COLOURED ?

The various pigments i.e. **anthocyanins** are responsible for the colour of flowers. All anthocyanins are found dissolved in the cell sap. They are responsible for red, blue, purple and a variety of other colours in flowers, fruits, young leaves etc. The different shades due to anthocyanin pigments are dependent upon concentration of pigments, p^H of the cell sap, relative proportion of different pigments etc. All anthocyanins are red in acidic solution and violet to blue in alkaline media.

Anthoxanthins are colourless, yellow or orange coloured pigments. Chemically, they are similar to anthocyanins. They are also soluble in water and are found in the cell sap. White colour of the flowers is mostly due to the presence of a colourless form of anthoxanthin. The colour of citrus fruits is also due to the presence of anthoxanthin.

EXPERIMENT 1

To find out the names of flowering plants in the garden, their flowering season and colour of their flowers.

Material Required

Pestle and mortar, beakers, Test tubes, dil. hydrochloric acid, dil. sodium hydroxide pH paper.

Procedure

(i) Visit the garden in various seasons and observe the flowering plants, their flowering seasons and colour of their flowers.

(ii) Take a few flowers of a species and separate their petals. Grind the petals in water with the help of pestle and mortar. Filter the squash and obtain the filtrate.

Test the pH of the filtrate with the pH paper. If it is acidic, add a few drops of dil. NaOH. Observe the change in colour.

Similarly, obtain the extract of flowers of different colours and find out the change in colour by addition of dilute acid/alkali.

Inference

Different flowering plants flower in different seasons and have different colours. Their colours is due to water soluble pigments called anthocyanins. Change in pH causes change in colour of flower extract (anthocyanins).

ORAL QUESTIONS

Q. 1. *Which pigment causes colouration in flowers ?*

Ans. Anthocyanin.

Q. 2. *Anthocyanins are present in both tomato and brinjal fruits but ripened tomato is red whereas brinjal is violet. Why is this ?*

Ans . Red colour of tomato is due to acidic medium. Anthocyanins give red colour in acidic medium. In brinjals cell sap of the fruit skin is alkaline, so anthocyanins give it violet colouration.

Q. 3. *In what way flower colour is beneficial to the plant itself ?*

Ans. Coloured flowers attract insects to effect pollination.

Q. 4. *What pigments cause white colour in flowers ?*

Ans. Anthoxanthins.

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INVESTIGATORY PROJECT 22

PRODUCTIVITY CAPACITY OF PLANTS

ESTIMATION OF PRODUCTIVE CAPACITY IN FIVE PLANTS GROWN UNDER DIFFERENT CONDITIONS

Aim : To study the effect of different conditions on the productivity of plants.

PRODUCTIVITY OF PLANTS

Productivity of a plant depends upon its growth, flowering capacity, minerals available, light, temperature and water. Deficiency of any one of the factors adversely affects the productivity of the plant. Even availability of a required environmental factor at a proper time is also very important. For example, at the ripening time of fruits, plants require proper light and relatively high temperature, otherwise maturation of fruits is delayed.

Material Required

Seeds of tomato/brinjal/any other plant you select and six pots filled with soil.

Procedure

Sow seeds of tomato/brinjal/ any other plant in a pot. Supply water to them from time to time. Take five pots and transplant one young plant in each pot. Mark the pots A, B, C, D and E. Place pot A in an open place where normal light is available. Supply it water and fertilizer in proper ratio.

Place pot B in normal light and water it when required. Do not provide fertilizer to it.

Place pot C in dark and supply to it water and fertilizer.

Place pot D in normal light. Provide it with too much water. Supply it fertilizer in proper quantity.

Place pot E in normal light. Supply it water and compost manure in proper ratio.

Let the plants grow and produce fruits. Collect the mature fruits.

Observation

Note down the time of flowering, fruit formation and fruit maturation.

Weigh the fruits obtained from each plant and find out the difference. Measure the size of fruits of each plant and find out the average size.

Fill up the following table

S. No.	*Pot*	*Time of flowering*	*Time of Fruiting*	*Average wt. of fruits*	*Average size of fruits*
1.	A				
2.	B				
3.	C				
4.	D				
5.	E				

Inference : On the basis of your observations, write down the inference.

ORAL QUESTIONS

Q. 1. *If a plant did not get minerals in sufficient (required) quantities, what would be the result ?*

Ans. It would show symptoms of deficiency.

Q. 2. *On what factors productivity of a plant depends ?*

Ans. Productivity of plants depends on many factors such as light, temperature, soil, water etc.

Q. 3. *What would happen to a plant if it does not get sufficient water ?*

Ans . Its leaves would wilt. If it does not get sufficient water for a long period, the plant would die.

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INVESTIGATORY PROJECT 23

Chlorophyll Contents of Plants

STUDY OF CHLOROPHYLL CONTENTS IN PLANTS OF FIVE DIFFERENT SPECIES

Aim : To study chorophyll contents in plants of five different species.

Material Required :

1. Spanish Leaves
2. Leaves of cauliflower
3. Coleus leaves
4. Money plant leaves
5. Carrot leaves

Procedure :

By paper chromatography separate chlorophyll contents of each type of leaves as discussed in CORE EXPERIMENT-23 and prepare a comparative table.

INVESTIGATORY PROJECT 24

Stomata

TO STUDY OPENING AND CLOSING OF STOMATA

Refer CORE EXPERIMENT No. 19

INVESTIGATORY PROJECT 25

Osmosis and Plasmolysis in Plants

STUDY OF OSMOSIS AND PLASMOLYSIS IN PLANTS

Refer CORE EXPERIMENT No. 9-B

INVESTIGATORY PROJECT 26*

Study of stained preparations of algae, fungi and musci

STUDY OF STAINED PREPARATIONS OF ALGAE, FUNGI AND MUSCI

Refer CORE EXPERIMENT No. 13.

* Investigatory Project I of the syllabus.

VIVA – VOCE

Q. 1. *What do you mean by the term microscope ?*

Ans . It is an optical instrument with the help of which micro-organisms can be seen.

Q. 2. *Who invented the compound microscope ?*

Ans . In 1610 Galileo invented the compound microscope.

Q. 3. *How many types of microscopes you have seen ?*

Ans . (i) Dissecting microscope—simple microscope.

(ii) Compound microscope—complex.

(iii) Binocular microscope—complex.

Q. 4. *What is the main use of microscope ?*

Ans . The microscope enlarges and resolve the object, which can be seen by the eye.

Q. 5. *What is the magnification of the electron microscope ?*

Ans . It magnifies the object as much as 10,000 times of its original size.

Q. 6. *What do you understand by double lens system ?*

Ans. It is found in compound microscope, where two *i.e.*, objective lens and eyepiece lens, are present.

Q. 7. *What is the use of objective lens ?*

Ans. It magnifies the object present on the stage.

Q. 8. *What are the various magnifications of objective lens ?*

Ans . (i) Short low powers (S.L.P. 3.5x) (ii) 10^x (iii) 45^x (iv) 100^x.

Q. 9. *What is the use of eye lens ?*

Ans. It further magnifies the image of the object.

Q. 10. *Why eye lens piece has markings 5^x, 10^x, 15^x etc.*

Ans. It just shows the range of magnification.

Q. 11. *If you are using 10^x eye lens and 10^x objective lens, what will be the total magnification of the object ?*

Ans . The total magnification will be : $10 \times 10 = 100$ times of the original size.

Q. 12. *Why your microscope is provided with a mirror ?*

Ans. It is meant for the reflection of the light towards the object.

Q. 13. *Which type of mirror is found in the microscopes ?*

Ans. It is of plano-concave type *i.e.* one side is plane while other is concave.

Q. 14. *What is the use of concave and plane side in the mirror ?*

Ans . Concave side is used when the light is not very bright because it converges all the light rays while plane side is used when the light is bright.

Q. 15. *What is a condenser ?*

Ans. It is a small apparatus fitted in the microscope just below the stage and helps in concentrating the light rays direct to the object.

Q. 16. *Who discovered microbes ?*

Ans. A Dutch scientist, Antony Van Leeuwenhoek (1632-1723) was the person, who saw and described microbes for the first time.

Q. 17. *Who constructed the electron microscope ?*

Ans. Knoll and Ruska from Berlin constructed the first practical electron microscope in 1931.

Q. 18. *To which kingdom all these microbes belong ?*

Ans . All these microbes belong to a separate kingdom Protista.

Q. 19. *What type of cellular organisation is found in the kingdom Protista ?*

Ans. In kingdom Protista two types of cellular organisations are found, (i) Prokaryotic and (ii) Eukaryotic.

Q. 20. *What organisms do you find in the soil ?*

Ans. Spores of Algae, Fungi, Bacteria, Protozoans and Nematodes etc. are present in the soil.

Q. 21. *What is Gram's stain ?*

Ans. It is a stain used to differentiate Gram (+) and Gram (–) bacteria. It is crystal voilet stain followed by iodine treatment. Since it is discovered by Gram, it is known as Gram's stain.

Q. 22. *What are Gram (+) and Gram (–) bacteria ?*

Ans . Those bacteria which take Gram's stain i.e. become blue are gram (+) while those which do not take the stain and remain red in colour are Gram (–) bacteria. Some bacteria do not take any stain, are known as acid fast bacteria.

Q. 23. *Name few bacterial disease of human beings ?*

Ans. Tuberculosis, Pneumonia, Cholera, Typhoid, Tetenus, Food poisoning etc.

Q. 24. *Name few bacteria, causing important diseases in man ?*

Ans . (i) Tuberculosis - *Mycobacterium tuberculosis.*

(ii) Pneumonia - *Diplococous pnecumoniae.*

(iii) Typhoid - *Salnonella typhosa.*

(iv) Cholera - *Vibrio cholerae.*

(v) Tetanus - *Clostridium tetani.*

(vi) Food poisoning - *Clostridium botultinum.*

Q. 25. *Why Bacteria are included in Plants ?*

Ans . Because of the cell wall.

Q. 26. *How symbiotic bacteria are helpful for the plant ?*

Ans . They fix up the atmospheric nitrogen which is utilized by the plants.

Q. 27. *Is there any difference between algal and bacterial flagella ?*

Ans . Yes, Algal flagella if seen anatomically has 2+g organization, while no such organisation is found in bacterial flagella.

Q. 28. *Why the milk kept in open becomes sour after some time ?*

Ans . It is because of the fermentation action of lactic acid bacteria (*Lecto bacilli*), which convert the lactose of the milk into lactic acid.

Q. 29. *What do you mean by pasteurization ?*

Ans . It is usually done in case of milk. The milk is first boiled at 150°C destroying a number of bacteria. This is followed by cooling of milk.

Q. 30. *Who discovered the first antibiotic ?*

Ans . Sir Alexander Fleeming in 1928 discovered first antibiotic Penicillin.

Q. 31. *Name some important centers of antibiotic research ?*

Ans . (i) Bose Institute, Calcutta.

(ii) Hindustan Antibiotics, Pimpri (Poona).

(iii) Indian Drugs & Pharmaceuticals Ltd., Rishikesh (U.P.).

Q. 32. *Are algae plants ?*

Ans . According to some these are plants (thallophytes) while according to the modern view, they are included in Kingdom Protista i.e. they are not plants.

Q. 33 . *What is phycology ?*

Ans. Phycology is a branch of plant science dealing with the study of algae.

Q. 34. *What are Thallophytes ?*

Ans. Thallophytes are plants without vascular system and the body is not differentiated into root, stem and leaves. Their sex organs are never surrounded by sterile layer.

Q. 35. *How would you differentiate between cellular and acellular organisms ?*

Ans . Cellular organisms have a definite cell wall which gives shape to the cell while it is absent in acellular ones.

Q. 36. *Name any unicellular alga.*

Ans. 1. *Chlorella* (nonmotile).

2. *Chlamydomonas* (motile).

Q. 37. *Name the alga which has gone to space ?*

Ans. *Chlorella.*

Q. 38. *Why Chlorella is choosen for space flight ?*

Ans . Because of 1. Food value, 2. Easily culturable, 3. Light in weight.

Q. 39. *What is the difference between chloroplast and chromatophore ?*

Ans . Chloroplast contain chlorophyll while it is absent in chromatophores.

Q. 40. *Do the algae live symbiotically with others ?*

Ans . Yes, members of blue green algae as well as Chlorophyceae live symbiotically with fungi to form a unique combination of the Lichens.

Q. 41. *Why Spirogyra is commonly known as pond silk ?*

Ans . The filaments of Spiragyra are alimy in texture.

Q. 42. *Why the filament of Spirogyra gives green colour after conjugation ?*

Ans . Green colour is because of chloroplast in the cells but when conjugation takes-place all the cell contents form gametes which fuse to form black zygospores.

Q. 43. *Have you heard about diatoms ?*

Ans . Yes, they are the members of class Bacillariophyceae (golden brown algae).

Q. 44. *What are planktons ?*

Ans . Algae occuring in water in the free floating stage forming scum on the pond surface are known as planktons.

Q. 45. *What are Benthons ?*

Ans . Plants occuring deep in fresh and marine water in attached conditions are commonly called as Benthons or Banthophytes.

Q. 46. *What are the advantages of asexual reproduction ?*

Ans . (i) Individual multiplies very rapidly.

(ii) Large number of young ones are produced at a time.

(iii) Presence of two partners is not required.

Q. 47. *What are the disadvantages of sexual reproduction ?*

Ans. (i) Vigour and vitality is lost.

(ii) It results into degeneration of sex.

Q. 48. *Name any alga which can fix atomospheric nitrogen ?*

Ans . Several blue green algae i.e. Nostoc, Anabaena etc.

Q. 49. *What do you mean by obligate parasite ?*

Ans . Those parasites which usually take their food from living hosts, and can also be cultured in the laboratory but do not occur as saprophytes in nature, are known as obligate parasites e.g. *Puccinia.*

Q. 50. *What do you mean by facultative saprophytes ?*

Ans . Those members which are usually parasites but can also live on dead organic matter, are termed as facultative saprophytes.

Q. 51. *Can you name any unicellular fungus ?*

Ans . Yes, yeast (*Saccharomyces*) is a unicellular fungus.

Q. 52. *Why yeast is important in wine making industry ?*

Ans. Because of the quality of fermentation which is due to the activity of enzymes zymase and invertase.

Q. 53. *Why Rhizopus is commonly called a bread mold ?*

Ans . Because it generaly spoils bread by growing on it saprophytically.

Q. 54. *How will you differentiate between Mucor and Rhizopus ?*

Ans. In *Mucor* sporangiophores are developed singly and from any point of mycelium while in *Rhizopus* sporangiophores develop in cluster and that too from specific points.

Q. 55. *What do you mean by the term heterothallism ?*

Ans . This term is often used for fungi. When the compatible nuclei are present on different hyphae, the fungus is known as heterothallism.

Q. 56. *Why Rhizopus from a single spore culture does not produce zygospores ?*

Ans. It is because of the fact that *Rhizopus* is heterothallic, zygospores will only by produced when two gametangia of opposite strains meet.

Q. 57. *From which organism the streptomyces is extracted ?*

Ans. It is obtained from a bacterium *Streptomyces grieseus.*

Q. 58. *What are fairy rings.*

Ans. These are the members of *Agaricales* e.g. *Agaricus praerimosus* and *Marasmius oredeus* etc.

Q. 59. *Why they are known as fairy rinos ?*

Ans . The fruiting bodies develoop in a circle because of centrifugal growth of the mycelium and is also considered as path of dancing fairies.

Q. 60. *Name any gill fungus.*

Ans. *Agaricus*, where basidia are developed on gills or lamellae.

Q. 61. *What are fungicides ?*

Ans. The chemicals used against fungi are known as fungicides.

Q. 62. *What are Lichens ?*

Ans . Lichen is a unique combination of an algae and a fungus.

Q. 63. *How do Lichens get their nutrition ?*

Ans . The raw material is absorbed from the substratum and the food material is synthesized by the algal partner by photosynthesis.

Q. 64. *How Lichens differ from fungi ?*

Ans . Lichens are autotrophic while fungi are heterotrophic. Lichens can grow on barren rocky places while fungi require dead or living organic matter.

Q. 65. *Where do you find Lichens ?*

Ans. Lichens are quite common in moist shady cool climate generally in the hilly regions.

Q. 66. *What is the ecological importance of Lichens ?*

Ans. Lichens are said to be the pioneers in establishing vegetation on bare rocky areas.

Q. 67. *In the roots of which plant the bacteria live symbiotically ?*

Ans. They live in symbiosis with the roots of leguminous plants.

Q. 68. *Name the bacteria present in the root nodules ?*

Ans. *Rhizobium, Azotobacter etc.*

Q. 69. *What is fermentation ?*

Ans. It is the process in which slow decomposition of organic chemical compunds into simpler ones and takes place due to the activity of micro organism, viz., Bacteria, yeasts etc.

Q. 70. *What is Gram's stain ?*

Ans. It is a stain used to differentiate gram (+) and gram (–) bacteria. It is crystal voilet atain followed by iodine treatment. It was discovered by Hans chrustian Gram and hence it is known as Gram's stain.

Q. 71. *What are gram (+) bacteria and gram (–) bacteria ?*

Ans . Those bacteria which take gram's stain i.e., become blue are gram (+) while those, which do not take and remain red in colour are gram (–) bacteria. Some bacteria do not take any stain, are known as acid fast bacteria.

Q. 72. *What are Bryophytes ?*

Ans. These are non-vascular thalloid autotrophic gametophytic plants with multicellular organs surrounded by a sterile jacket.

Q. 73. *What do you mean by Bryology ?*

Ans. It is the study of plants included in Bryophytes.

Q. 74. *What is progressive evolution theory ?*

Ans . According to this theory the simpler members have given rise to complex forms i.e. simpler forms are primitive and complex forms are advanced.

Q. 75. *What are gemmae ?*

Ans. They are multicellular green bodies found in Bryophytes and help in vegetative multiplication.

Q. 76. *What are liverworts ?*

Ans. These are the members of the class Hepaticae e.g. *Riccia, Marchantia* etc.

Q. 77. *Which is the largest Bryophyte ?*

Ans. *Dawsonis* is the largest Bryophyte which measures about 70 cms. in height.

Q. 78. *Why bryophytes are known as amphibians ?*

Ans. Because these plants lives both in soil and in water.

Q. 79. *Why Bryophytes are included in non-vascular plants ?*

Ans. Because the vascular tissues i.e., xylem and phloem are absent in the members of Bryophytes.

Q. 80. *What are Pteridophytes ?*

Ans. They are the members of Crypogams with well developed vascular system. According to the later classification they belong to phylum Tracheophyta.

Q. 81. *What do you mean by term stele ?*

Ans. The central vascular cylinder surrounded by the endodermis is called as stele.

Q. 82. *Can you name any homosporous member of this group ?*

Ans. Yes, *Equisetum.*

Q. 83. *What is apospory ?*

Ans. The production of gametophyte directly from the sporophyte without the formation of spores is called apospory.

Q. 84. *How can you say Marsilea is a fern ?*

Ans. Because leaves show circinnate vernation in young condition.

Q. 85. *What do you understand by the term spermatophyte ?*

Ans. This is a group of plants which produce seeds.

Q. 86. *What are the two major groups of spermatophyta ?*

Ans. In includes (i) Gymnosperms (ii) Angiosperms.

Q. 87. *What are Gymnosperms ?*

Ans. It is a group of plants with naked ovules and seeds or without ovary.

Q. 88. *Name the important workers in India, who have contributed to this branch.*

Ans. Late Prof. Birbal Sahni, D.D. Pant, Raizada and Sahni etc.

Q. 89. *Why Cycas is called as bread palm ?*

Ans. In Japan the stem is crushed and bread is prepared.

Q. 90. *How will you differantiate between palm and Cycas tree ?*

Ans. (i) Palm leaves have parallel venation while *Cycas* leaf has only a single rib.

(ii) Stem of Cycas is surrounded by an armour of persistant leaf bases while no such thing is found in the stem of palm.

Q. 91. *What are coralloid roots and in which plant, they are found ?*

Ans . They are coral like small club shaped roots infected by algae, apogeotropic in nature and are found in Cycas plants.

Q. 92. *Which algae are present in the coralloid roots ?*

Ans . Usually blue green algae are present e.g., *Nostoc, Anabaena.*

Q. 93. *Which is the tallest sp. of Cycas ?*

Ans. *Cycos madia* which is 20 feet in height.

Q. 94. *Can you calculate the age of Cycas plant ?*

Ans . Yes by calculating the rings formed by the leaves, the age can be determined. In a year a single crown of foliage is developed.

Q. 95. *What is diploxylic condition ?*

Ans. When centripetal and centrifugal xylem are present, the condition is known as diploxylic.

Q. 96. *Which genus in Gymnosperms has angiosperm like leaves ?*

Ans. *Gnetum* has angiospermic leaf.

Q. 97. *What is pycnoxylic wood ?*

Ans. When wood is hard compact, it is known as pycnoxylic wood and is found in conifers.

Q. 98. *What is the characteristic feature of conifers ?*

Ans . Resin canals are present, wood is pycnoxylic, Male gametes non-motile. Polyembryony is common.

Q. 99. *Where do you find these conifers ?*

Ans . They are widely distributed in temperate regions, hilly areas etc. Some are found growing even in plains.

Q. 100. *What is male cone ?*

Ans. It is a compact aggregation of several microsporophyles bearing microsporangia.

Q. 101. *What is maiden hair tree ?*

Ans. *Ginkgo biloba* is known as maiden hair tree.

Q. 102. *Why Ginkgo is known as living fossil ?*

Ans. *Ginkgo biloba* is the only living representative of this fossalized order. Hence it is known as living fossil.

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